Sandia National Laboratories/New Mexico

# PROPOSALS FOR NO FURTHER ACTION ENVIRONMENTAL RESTORATION PROJECT

4 1 of 2

June 1998

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

# EXECUTIVE SUMMARY

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a Hazardous and Solid Waste Amendments (HSWA)/Corrective Action (CA) related permit modification based upon No Further Action (NFA) Proposals for Environmental Restoration (ER) Solid Waste Management Units (SWMU). SWMUs 27, 14, 17,103, and 108 are listed in the HSWA Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1992).

## OPERABLE UNIT 1332

SNL/NM is proposing a risk-based NFA decision for SWMU 27, Building 9820 (Animal Disposal Pit), OU 1332. SWMU 27 is the former location of an animal disposal pit and other buried debris. Based upon historical and process knowledge, field investigation data, remediation and confirmatory sampling data, and human health and ecological risk screening assessments, an NFA decision is recommended for SWMU 27 for the following reasons.

- All debris was removed from SWMU 27 during the RCRA Facility Investigation (RFI)/Voluntary Corrective Measures (VCM) excavation activities and was confirmed by collection and analysis of confirmatory soil samples.
- No nonradiological or radiological constituents of concern (COC) at concentration or activity levels considered hazardous to human health for a recreational land-use scenario were present in soil remaining at the site.
- No volatile organic compounds (VOC) or radionuclides were detected during the RFI/VCM field-screening programs.
- The risk screening assessment for ecological receptors indicates that the ecological risks associated with SWMU 27 are insignificant.

## OPERABLE UNIT 1335

SNL/NM is proposing a risk-based NFA decision for SWMU 14, Burial Site, OU 1335. SWMU 14 is a burial site of glass debris resulting from an explosives above-ground test that involved 6,000 to 8,000 fluorescent light bulbs. Potential COCs are mercury, residual high explosives (HE) and depleted uranium (DU). A confirmatory sampling investigation conducted in the area determined that there was no significant debris or COC present in the area, thereby validating reports that an insignificant amount of material was buried. Based upon field investigation data and the human health risk screening assessment, an NFA is being recommended for SWMU 14 for the following reasons:

- All anomalous material (discolored soil) found in the trenches was sampled and excavated. The material was nonhazardous.

- There was no evidence of mercury from either the field screening or from laboratory analyses, and the total amount of mercury used in the test was insignificant (less than 1 pint).

- There was no evidence of explosives. All samples analyzed for explosives were nondetected.

- Human health and ecological risk screening assessments indicate no impact of the COCs to human health or the environment.

SNL/NM is proposing a risk-based NFA decision for SWMU 17, Scrap Yards, OU 1335. SWMU 17 contains eight inactive scrap yards used to support testing activities at South Thunder Range. Based upon historical and process knowledge, field investigation data, and human and ecological risk screening assessments, an NFA decision is recommended for SWMU 17 for the following reasons:

- All radiological anomalies detected at SWMU 17B were confirmed remediated following the VCM removal activities.

- No nonradiological or radiological COCs were present in soil at concentrations or activity levels considered hazardous to human health for an industrial land-use scenario.

- Risk screening assessment for ecological receptors indicates that the ecological risks associated with SWMU 17 are expected to be insignificant.

SNL/NM is proposing a risk-based NFA decision for SWMU 103, Scrap Yards, OU 1335. SWMU 103 encompasses SWMU 117 (Sodium Pit) and the buildings (including 9939) and structures associated with the Large-Scale Melt Facility. Based upon field investigation data and the human health and ecological risk screening assessment, an NFA is recommended for SWMU 103 for the following reasons:

- All radiological anomalies detected at SWMU 103 were confirmed remediated following the VCM removal activities.

- No nonradiological or radiological COCs were present in soil at concentrations or activity levels considered hazardous to human health for an industrial land-use scenario.

- Risk screening assessment for ecological receptors indicates that the ecological risks associated with SWMU 103 are expected to be low.

SNL/NM is proposing a risk-based NFA decision for SWMU 108, Firing Site (Building 9940), OU 1335. SWMU 108 consists of a bunker and several supporting structures (sheds and office trailers) that were used for explosives testing and reactor safety experiments. Based upon

historical and process knowledge, field investigation data, and human health and ecological risk screening assessments, an NFA decision is recommended for SWMU 108 for the following reasons:

- All radiological anomalies detected at SWMU 108 are confirmed to be remediated following the VCM removal activities.
- No nonradiological or radiological COCs were present in soil at concentrations or activity levels considered hazardous to human health for an industrial land-use scenario.
- Risk screening assessment for ecological receptors indicates that the ecological risks associated with SWMU 108 are insignificant.

Based upon the evidence provided above, SWMUs 27, 14, 17, 103, and 108 are proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states that the SWMUs have been fully characterized and remediated in accordance with current and applicable state or federal regulations and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use.

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**Annex**

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| bgs | below ground surface |
| BLM | Bureau of Land Management |
| CEARP | Comprehensive Environmental Assessment and Response Program |
| cm | centimeter(s) |
| $cm^2$ | square centimeter(s) |
| COC | constituent of concern |
| COPEC | constituent of potential ecological concern |
| cps | counts per second |
| DCF | dose conversion factor |
| DOE | U.S. Department of Energy |
| dpm | disintegration(s) per minute |
| DQO | Data Quality Objective |
| DU | depleted uranium |
| EOD | Explosive Ordnance Disposal |
| EPA | U.S. Environmental Protection Agency |
| ER | environmental restoration |
| FCI | fuel coolant interaction |
| FITS | Fully Instrumented Test System |
| FOP | field operating procedure |
| HASP | health and safety plan |
| HE | high explosives |
| HEAST | Health Effects Assessment Summary Tables |
| HI | hazard index |
| HMX | 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane |
| HP | health physics |
| HRMB | Hazardous and Radioactive Materials Bureau |
| HQ | hazard quotient |
| ID | identification |
| IH | industrial hygiene |
| IRIS | Integrated Risk Information System |
| KAFB | Kirtland Air Force Base |
| kg | kilogram(s) |
| L | liter(s) |
| LAS | Lockheed Analytical Services |
| lb | pound(s) |
| LOAEL | lowest-observed-adverse-effect level |
| $m^3$ | cubic meter(s) |
| MDA | minimum detectable activity |
| MDC | Melt Development Corium |
| MDL | method detection limit |
| µg | microgram(s) |
| µR/hr | microroentgen(s) per hour |

## ACRONYMS AND ABBREVIATIONS (Concluded)

| | |
|---|---|
| mg | milligram(s) |
| mi | mile(s) |
| mrem | millirem(s) |
| NOAEL | no-observed-adverse-effect level |
| NFA | no further action |
| NMED | New Mexico Environment Department |
| NRC | U.S. Nuclear Regulatory Commission |
| OP | operating procedure |
| OU | operable unit |
| PCB | polychlorinated biphenyl |
| pCi/g | picocurie(s) per gram |
| PID | photoionization detector |
| PRG | Preliminary Remediation Goals |
| QA | quality assurance |
| QC | quality control |
| RAGS | Risk Assessment Guidance for Superfund |
| RCRA | Resource Conservation and Recovery Act |
| RCT | radiation control technician |
| RFI | RCRA facility investigation |
| RME | reasonable maximum exposure |
| RMMA | Radioactive Materials Management Area |
| RP | Radiation Protection |
| RPD | relative percent difference |
| RPSD | Radiation Protection Sample Diagnostics |
| SNL/NM | Sandia National Laboratories/New Mexico |
| SVOC | semivolatile organic compounds |
| SWHCP | Site-Wide Hydrogeologic Characterization Project |
| SWMU | solid waste management unit |
| TA | Technical Area |
| TAL | target analyte list |
| TCL | target compound list |
| TCLP | toxicity characteristic leaching procedure |
| TEDE | total effective dose equivalent |
| USFS | U.S. Forest Service |
| UXO | unexploded ordnance |
| VCM | voluntary corrective measure |
| VOC | volatile organic compounds |
| yr | year |

# 1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a Hazardous and Solid Waste Amendments (HSWA)/Corrective Action (CA) related permit modification based upon No Further Action (NFA) Proposals for Environmental Restoration (ER) Solid Waste Management Units (SWMU). The following SWMUs are listed in the HSWA Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1992). Proposals for each SWMU are located in this document as follows:

Operable Unit 1332

- SWMU 27, Building 9820 (Animal Disposal Pit) (Section 2.0)

Operable Unit 1335

- SWMU 14, Burial Site (Building 9920) (Section 3.0)
- SWMU 17, Scrap Yards/Open Dump (Thunder Range) (Section 4.0)
- SWMU 103, Scrap Yard (Building 9939) (Section 5.0)
- SWMU 108, Firing Site (Building 9940) (Section 6.0)

These proposals each provide a site description, history, summary of investigatory activities, and the rationale for the NFA decision.

# 5.0 SOLID WASTE MANAGEMENT UNIT 103, SCRAP YARD (BUILDING 9939)

## 5.1 Summary

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Solid Waste Management Unit (SWMU) 103, Scrap Yard, Operable Unit (OU) 1335. SWMU 103 encompasses SWMU 117 (Sodium Pit) and the buildings (including 9939) and structures associated with the Large-Scale Melt Facility. SWMU 117, the Sodium Pit, will be addressed under a future NFA proposal submission. Review and analysis of all relevant data for SWMU 103 indicate that concentrations of constituents of concern (COC) at the site are less than applicable risk assessment action levels. Thus, SWMU 103 is proposed for an NFA decision based upon confirmatory soil sampling demonstrating that COCs that may have been released from the SWMU into the environment pose an acceptable level of risk under current and projected land use as set forth by Criterion 5, which states "The SWMU/AOC has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998).

## 5.2 Description and Operational History

### 5.2.1 Site Description

SWMU 103 is located on approximately 6 acres west of Lovelace Road about 2 miles south of Coyote Springs Road and 1.6 miles north of the Solar Power Tower (Figure 5.2.1-1). SWMU 103 is associated with the Large-Scale Melt Facility, an active site used to test nuclear reactor meltdown scenarios. The furnace and power source are scheduled for dismantlement and relocation. Discussions are underway to determine the future of the facility, including returning the facility to the U.S. Air Force (Wrightson May 1998). The scrap yard within SWMU 103 contains used and unused concrete crucibles from operations in Building 9939, sheet metal structures, large metal bins, and several large tanks. The scrap items do not contain hazardous or radioactive materials based upon surveys conducted by SNL/NM industrial hygiene and radiation protection. In addition, the scrap items are not considered waste and will remain on site as authentication of prior test results. The site is located on U.S. Air Force land permitted to the U.S. Department of Energy (DOE) and SNL/NM.

SWMU 103 lies on the eastern margin of the Sandia-Tijeras Fault complex at an elevation of 5,612 feet above mean sea level. The terrain is generally flat with a gentle slope to the west. The 1994 Site-Wide Hydrogeologic Characterization Project (SWHCP) Annual Report (SNL/NM March 1995) presents general soil characteristics for the area around SWMU 103. The dominant surface soil group in the area is Wink fine sandy loam. The soil infiltration rate is estimated to be on the order of 0.1 centimeter per year (cm/yr), which yields downward seepage velocities ranging between 0.03 and 11.8 cm/yr (SNL/NM March 1995).

SWMU 103 is located in the HR-2 hydrological region described in the 1994 SWHCP Annual Report (SNL/NM March 1995). This region is a transitional geohydrologic zone between the

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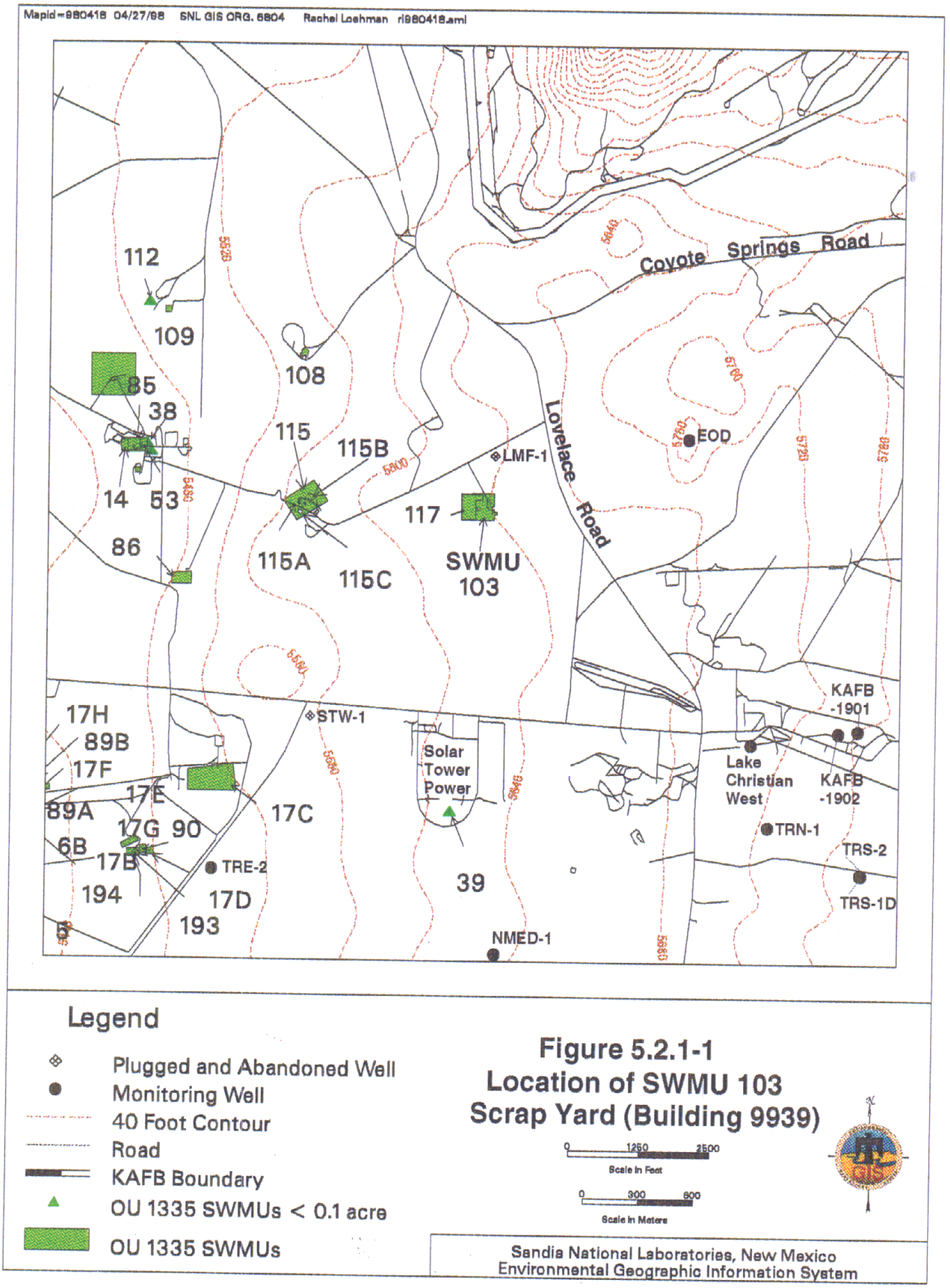
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Coyote Springs Road
Lovelace Road
112
109
108
85
38
115
115B
LMF-1
EOD
14
53
117
86
115A
115C
SWMU
103
17H
89B
17F
17E
89A
17G
90
6B
17B
17C
TRE-2
194
17D
193
5
STW-1
Solar
Tower
Power
39
NMED-1
KAFB
-1901
Lake
Christian
West
KAFB
-1902
TRN-1
TRS-2
TRS-1D
Legend
Plugged and Abandoned Well
Monitoring Well
40 Foot Contour
Road
KAFB Boundary
OU 1335 SWMUs < 0.1 acre
OU 1335 SWMUs
Figure 5.2.1-1
Location of SWMU 103
Scrap Yard (Building 9939)
0 1250 2500
Scale in Feet
0 300 600
Scale in Meters
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

HR-1 zone to the west and the HR-3 zone to the east. It is comprised of a northeast/southwest-trending fault complex that includes segments of the Sandia, Tijeras, and Hubbell Springs Faults. It has been determined that the uppermost interval of groundwater saturation in HR-2 is unconfined to semiconfined aquifers in the alluvial facies of the Santa Fe Group and piedmont alluvium and semiconfined to confined aquifers in the local bedrock units. These faults not only complicate the local hydrostratigraphy but also are likely to have a significant impact on groundwater flow. The estimated hydraulic conductivity of the local aquifers is highly variable—from approximately 0.004 to 0.10 feet per minute (ft/min) in the shallow alluvium; 0.00001 to 0.0005 ft/min in the Santa Fe Group alluvial fan facies; and 0.000002 to 0.007 ft/min in bedrock units (SNL/NM March 1995).

The nearest groundwater monitoring well, LMF-1 (now plugged and abandoned), is located approximately 1,400 feet from SWMU 103 and the Large-Scale Melt Facility. The depth to groundwater at LMF-1 ranged between 335 feet (January 1996) and 292 feet (December 1996) (SNL/NM March 1997). The uppermost interval of groundwater saturation underlying SWMU 103 is the Abo Sandstone aquifer unit. Local groundwater flow is predominantly to the west, although nearby fault boundaries may significantly alter the flow direction (SNL/NM March 1996). The nearest production well, KAFB-4, is located approximately 5 miles northwest of the site. No perennial surface-water bodies are present in the vicinity of SWMU 103.

For a detailed discussion regarding the local setting at SWMU 103, refer to the "RCRA Facility Investigation Work Plan for OU 1335, Southwest Test Area" (SNL/NM March 1996).

### 5.2.2 Operational History

Originally designed as a facility where explosives would be formulated, Building 9939 at the Large-Scale Melt Facility was constructed in 1971 (Hyde June 1992, Wrightson October 1995a, Wrightson October 1995b, Wrightson October 1995c). However, the building was never used for this purpose; rather it was used to house a high-temperature autoclave (Wrightson 1995b). In early 1977, the building was adapted to conduct molten/core concrete interaction studies sponsored by the U.S. Nuclear Regulatory Commission (NRC). As of 1992, SNL/NM continued to conduct experiments in the facility to support reactor safety programs for customers such as the NRC, the DOE, and Westinghouse Savannah River Laboratories (Hyde June 1992). Currently, there is no activity at the site, and there are no plans to conduct molten core experiments at the facility. The furnace and power source are scheduled for dismantlement and relocation. Discussions are underway to determine the future of the facility, including returning the facility to the U.S. Air Force (Wrightson May 1998). Table 5.2.2-1 lists a concise history of the test activities at the Large-Scale Melt Facility.

The Large-Scale Melt Facility consists of a furnace system, an experimental chamber, remote control data acquisition buildings, and several abandoned spray pits (SWMU 117) that were used to dispose of residual material (sodium) from the test crucibles (Figures 5.2.2-1 and 5.2.2-2). The heart of the Large-Scale Melt Facility is its induction furnace and the associated power supplies, cooling equipment, and gas purging hardware (Powers [date unknown]). The induction furnace is mounted on a platform for melt preparation, and the test chamber, mounted on a concrete pad outside Building 9939A, is situated below the furnace for the interaction test (Figure 5.2.2-3).

Typical melt materials (i.e., those found in a simulated reactor core) included glass, mild steel, stainless steel, aluminum, iron oxide, oxide mixtures, and a depleted uranium (DU) oxide

## Table 5.2.2-1
## History of Experiments Conducted at the Large-Scale Melt Facility

| Date | Test Title[a] | Materials Used |
|---|---|---|
| 1977B1979 | NSS tests[b] | 66 lb DU-zirconium fuel metallothermic reactions in concrete crucible |
| 1977B1980 | PLATE Series | Molten iron-alumina melts on a DU-coated steel plate (conducted on west test Pad of 9939-A) (Quantity unknown) |
| 1977B1979 | FRAG | Approximately 7 tests involving 66 lb DU metallothermic mixture interacting with molten sodium[b] |
| 1977B1981 | Other tests involving sodium[c] or Sodium Containment/Structural Integrity Project[e] | 15 tests involving 100 to 200 lb sodium per test[d] |
| 1982 | Other uranium oxide tests | 3 tests, 440 lb DU |
| 1983 | IRIS Tests | 4 tests, 180 lb DU |
| 1984 | TURC-2 | 1 test, 220 lb DU |
| 1984B1985 | TURC-3 | 1 test, 220 lb DU |
| 12/86 | SURC-1 | 1 test 550 lb DU |
| 5/29/86 | QT-D | 20 lb 304 stainless steel, 2 kg zirconium/concrete/magnesium oxide |
| 8/4/86 | SURC-3 | 100 lb 304 stainless steel with zirconium/concrete/magnesium oxide |
| 9/30/86 | SURC-3A | 50 kg 304 stainless steel with zirconium/concrete/magnesium oxide |
| 12/16/86 | SURC-1 | 200 kg DU/zirconium dioxide/magnesium oxide |
| 3/25/87 | SURC-4 | 200 kg 304 stainless steel/Concrete/magnesium oxide |
| 6/88 | SRP-ST-1 | Aluminum concrete |
| 8/11/88 | SURC-1A | 440 lb DU zirconium dioxide, zirconium/concrete, magnesium oxide |
| 3/14/89 | SRL-1 | Aluminum/concrete/fission product simulants/aluminum oxide |
| 8/3/89 | SRL-2 | Aluminum/concrete/fission product simulants/aluminum hydroxide/aluminum oxide |
| 10/4/89 | SURC-2 | 440 lb DU/zirconium dioxide/concrete/magnesium oxide/aluminum hydroxide/aluminum oxide |
| 7/17/90 | SRL-3 | 165 lb aluminum/hydrogen/concrete/aluminum hydroxide/aluminum oxide |
| 8/90 | HACR-1 | Aluminum/hydrogen/aluminum oxide |
| 1990 | HACR-2 | Aluminum/aluminum oxide |
| 3/5/91 | WETGLASS-1 | Silica/304 stainless steel/water/magnesium oxide |
| 4/8/91 | WETGLASS-2 | Silica/304 stainless steel/water/magnesium oxide |
| 8/15/91 | JAERI-1 | 304 stainless steel/water/magnesium oxide |
| 9/5/91 | WETCOR-1 | Aluminum oxide/calcium oxide/hydrogen |
| 12/13/91 | WETMET-1 | 304 stainless steel/water/magnesium oxide |
| 1/23/92 | WETMET-1A | 304 stainless steel/water/magnesium oxide |
| 2/4/92 | JAERI-2 | 304 stainless steel/water/magnesium oxide |

[a]Complete names for test titles are not available.
[b]Chu and Brockman [date unknown].
[c]Author (Unknown), [date unknown].
[d]Byrd November 1992.
[e]Keltner [date unknown].
DU = Depleted uranium.
lb = Pound(s)
kg = Kilogram(s).

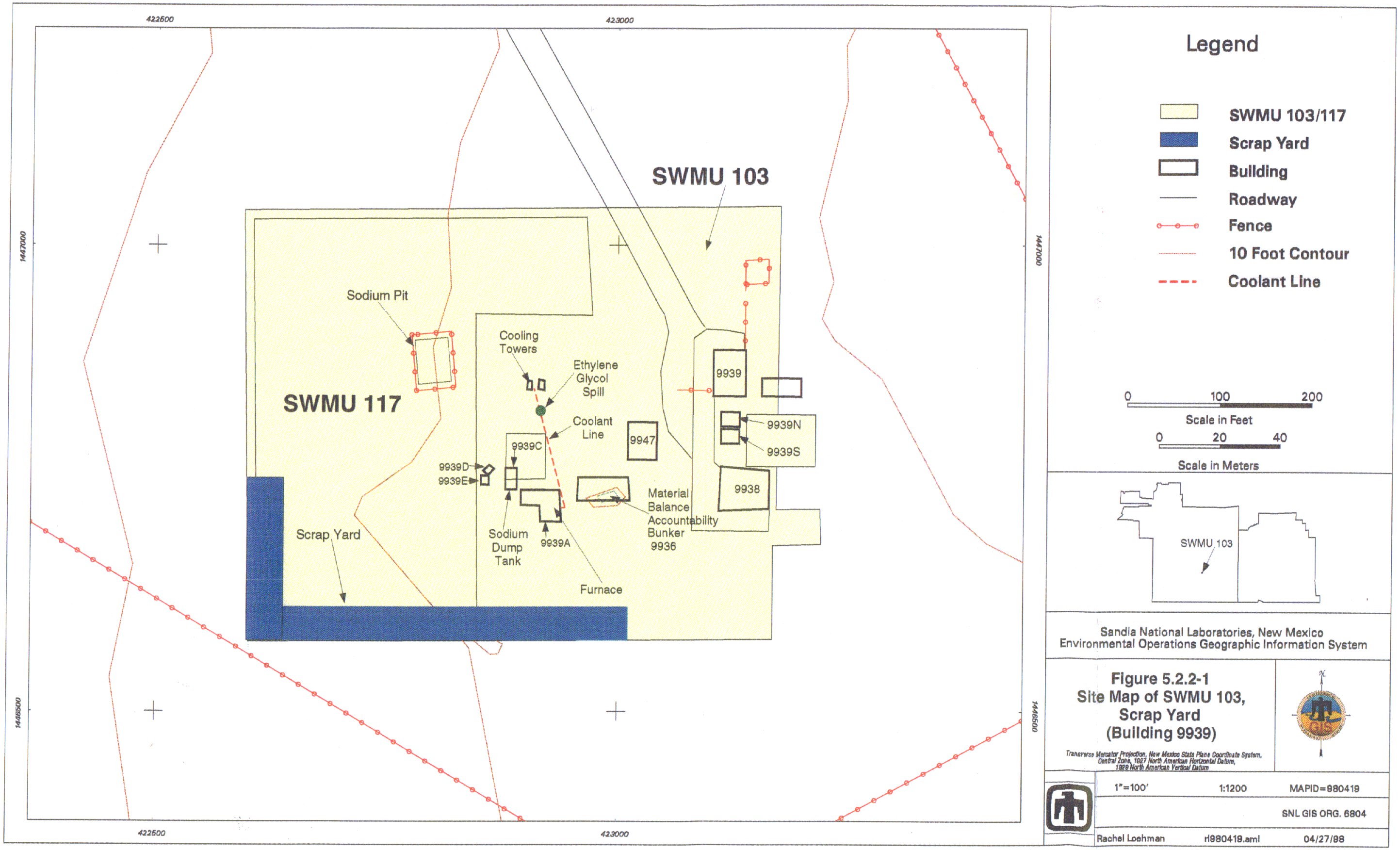
422500
423000
1447000
1446500
SWMU 103
SWMU 117
Sodium Pit
Cooling Towers
Ethylene Glycol Spill
Coolant Line
9939
9939N
9939S
9947
9939C
9939D
9939E
9938
Material Balance Accountability Bunker 9936
Scrap Yard
Sodium Dump Tank
9939A
Furnace
Legend
SWMU 103/117
Scrap Yard
Building
Roadway
Fence
10 Foot Contour
Coolant Line
0 100 200
Scale in Feet
0 20 40
Scale in Meters
SWMU 103
Sandia National Laboratories, New Mexico
Environmental Operations Geographic Information System
Figure 5.2.2-1
Site Map of SWMU 103, Scrap Yard (Building 9939)
Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1927 North American Horizontal Datum, 1929 North American Vertical Datum
1"=100'
1:1200
MAPID=980419
SNL GIS ORG. 6804
Rachel Loehman
ri980419.aml
04/27/98


**Figure 5.2.2-2**
**Large-Scale Melt Facility Test Chamber**

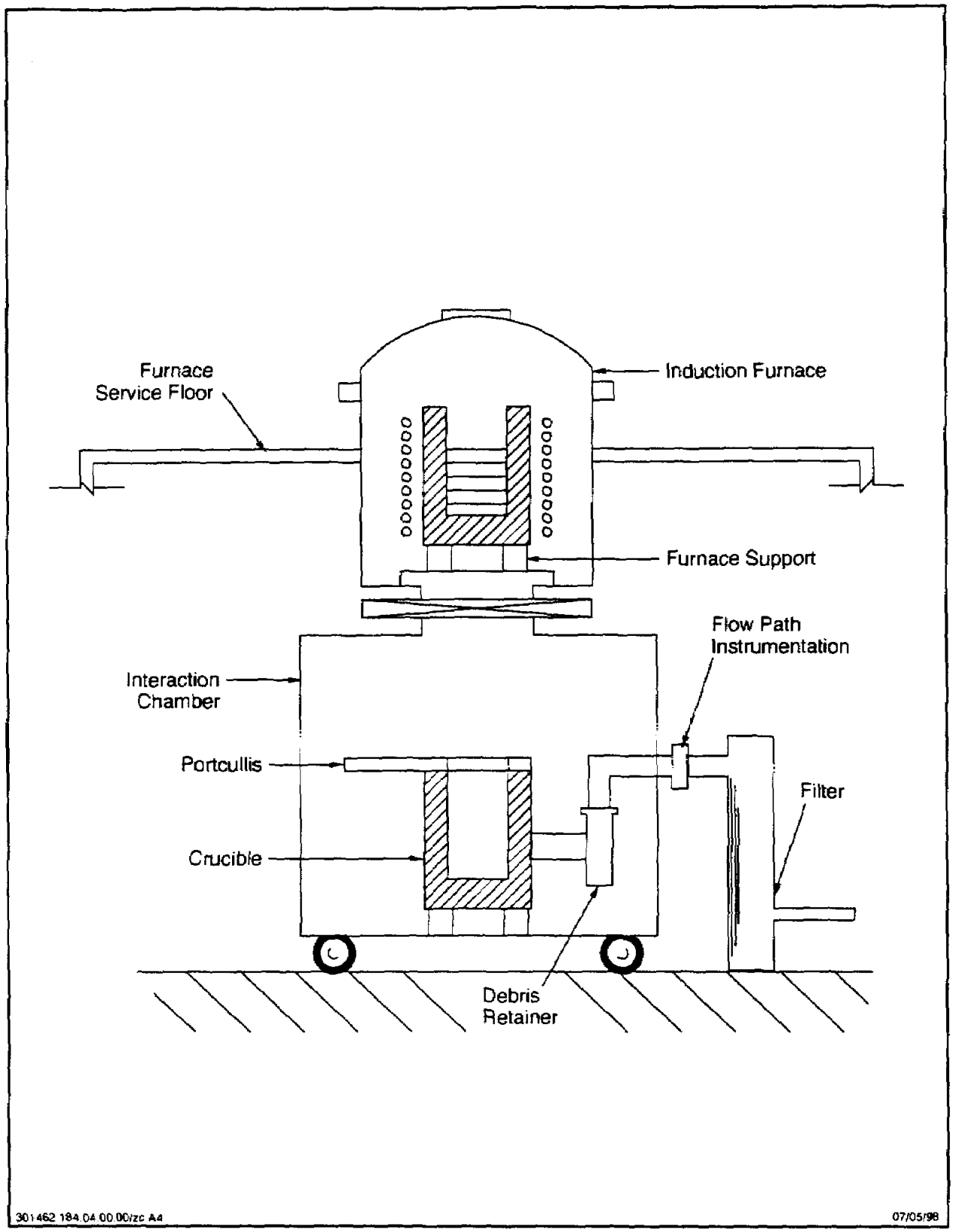


**Figure 5.2.2-3**
**Schematic of Large-Scale Melt Facility**

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mixture. Of all the simulants used, the DU oxide mixture was the most common (Hyde June 1992). When these materials reached a molten state in the furnace, they were released into a concrete crucible housed in the test chamber. The reaction between the molten materials and the concrete crucible was then analyzed. Because many of the tests used molten DU (Table 5.2.2-1), the crucibles were often coated with tungsten to maintain compatibility with the molten DU (Chu and Brockman [date unknown]).

The Large-Scale Melt Facility system was cooled by a closed-loop ethylene glycol cooling system. The ethylene glycol coolant was pumped through the furnace, then recycled through two cooling towers located approximately 100 feet north of the furnace through a 3-inch-diameter underground line. Water was sometimes introduced into the chamber in a continuous flow to quench the test crucible and was captured in a 560-gallon reservoir.

The effluents were comprised of gases (hydrogen, carbon monoxide, and carbon dioxide) (Wrightson October 1995a) and slag generated from the liquid that remained upon completion of the crucible tests. All gaseous effluents passed through a gravel/sand filter backed with a high-efficiency particulate air (HEPA) filter prior to being released to the atmosphere. The system was designed to pull a slight negative pressure on the containment vessel, thus eliminating the escape of effluents except through the flow system. All particulates were captured within the experimental apparatus (Hyde June 1992). Other sand and gravel filters had been used for removing debris from the slag. No hazardous material was associated with the debris. The slag was probably disposed of in the sodium crucible spray pits identified as SWMU 117 (Wrightson October 1995a).

The test chamber was designed to withstand an internal pressure of 2 atmospheres. A spring-loaded relief port prevents overpressurization. When the chamber was overpressured, the material was released to the atmosphere. However, of the overpressure events that were known to have occurred, all the material released was nonhazardous (molten steel and molten aluminum) (Wrightson October 1995a).

When DU was used, it was delivered to the facility in billets. In order for the DU to be loaded into the crucibles, it had to be crushed. The crushing and loading operation was conducted in Building 9939C (Figure 5.2.2-1). For this activity, a contamination step-off pad was put into place at the entrance, and a plastic film adhesive pad was placed inside the door. Workers wore anticontamination clothing and full-face respirators. Before the compressed billets could be ground into DU gravel, they were broken into workable chunks to be loaded into the crusher. The billet was placed on a thick plate of steel and hammered with a long steel bar. The chunks were then loaded into the crusher, and the gravel would fall into a large, seamless plastic box. After the DU was crushed, the dust that had settled on all surfaces (including the floor) was hand-swept into the box of gravel, and a lid was placed on the box.

When introduced to Building 9939C, the crucible was wrapped in plastic sheeting with the top open for loading. The DU was scooped into the crucible slowly to reduce stirring up its dust. Any leftover DU was bagged and returned to the Materials Balance Accountability storage bunker, Building 9936 (Figure 5.2.2-1). Upon completion of the loading operation, the upper edge of the crucible was tape-sealed for transport, and the outside plastic was wiped down and inspected for transferable contamination before the crucible was released to the test pad. After all of the operations at Building 9939C had been completed, tools and equipment were rinsed in a bucket of water and wiped with both wet and dry rags. The floor and walls were also wiped down. The water in the bucket was left to evaporate in the shed, and the rags were dried and then packaged with the other contaminated waste.

Sodium, used in the interaction tests, came in 55-gallon barrels that were heated up to 120 degrees fahrenheit and then transferred to the *dump tank* for additional heating (Figure 5.2.2-1). The sodium was transferred into the crucible at the start of the test. No spills occurred from this operation (Wrightson October 1995a).

After the tests had been completed, the crucible was removed to the *crucible spray pit* (SWMU 117). The residual sodium in the crucibles was exposed to a spray mist of water. A steel piece tilted the crucible so that the spray mist runoff was transferred into the pit. It typically took two to three weeks of spraying continually during the day to wash down all of the residue (Byrd November 1992).

The ethylene glycol closed-loop coolant system was designed to prevent a release into the environment in the event of a system failure. Even during catastrophic experiments, the coolant lines remained intact, although there have been instances of small leaks of ethylene glycol when the hoses to the furnace were disconnected (Wrightson October 1995a). Typically, 1 to 2 gallons drained from the hoses onto the pad.

In 1988, an underground leak occurred at the ethylene glycol feeder line that ran from the cooling towers approximately 100 feet north of the furnace to the coolant pump adjacent to the furnace on the east side of the pad. About 3,000 gallons were lost. Tank closure and site characterization were performed in 1997 (see Section 5.6.4). Figure 5.2.2-1 illustrates the approximate location of this release.

In the event that the closed-loop ethylene glycol system failed during a test, a secondary piping system was installed that utilized city water and discharged the water out the emergency drain onto the ground surface. It is believed that the water would not have come into contact with any DU metal (Byrd November 1992). However, the water did flow through the furnace chamber, where it would have come into contact with residual ethylene glycol in the chamber. The backup system was used in only one incident, and approximately 50 gallons were flushed down the drain.

The polychlorinated biphenyls (PCB) transformer oil was removed from the transformers on the north side of Building 9939C. The oil was contained when the transformers were removed (Wrightson October 1995a).

The scrap yard consists of used and unused concrete crucibles from operations conducted in Building 9939 (Figure 5.2.2-4a and b). No hazardous or radioactive materials are associated with the unused concrete crucibles stockpiled along the shoulders of the entrance road to the Large-Scale Melt Facility (Wrightson October 1995a) (Figures 5.2.2-1 and 5.2.2-4c). Most of the used crucibles stockpiled along the southern edge of the Large-Scale Melt Facility property were associated with the sodium-interaction tests; the JAERI-1 and 2 tests; the SRL-1, 2, and 3 tests; the SRLST-1 test; the HACR-2 test; the WETMET-1; and the WETCOR-1 test. Of these, the SRL-1 and 2 tests used simulated fission products. All other crucibles in the scrap yard, except for those crucibles used in the sodium-interaction tests, contained nonhazardous and nonradioactive materials. Other materials associated with the scrap yards include sheet metal structures that appear to be hoods or vents, some large metal bins, and two large tanks about 15 feet long.

Figure 5.2.2-4a SWMU 103 Scrap Yard

Figure 5.2.2-4b Used Concrete Crucibles at SWMU 103 Scrap Yard

Figure 5.2.2-4c Unused Concrete Crucibles Along Entrance Road to Large-Scale Melt Facility

## 5.3 Land Use

### 5.3.1 Current

SWMU 103 is located on U.S. Air Force property. The site is fee-permitted to the DOE and SNL/NM (Figure 5.3.1-1). The Large-Scale Melt Facility associated with SWMU 103 remains operational. The furnace and power source are scheduled for dismantlement and relocation. Discussions are underway to determine the future of the facility, including returning the facility to the U.S. Air Force (Wrightson May 1998).

### 5.3.2 Future/Proposed

SWMU 103 has been recommended for industrial land use (DOE and USAF March 1996).

## 5.4 Investigatory Activities

### 5.4.1 Summary

SWMU 103 was initially investigated under the DOE Comprehensive Environmental Assessment and Response Program (CEARP) in the mid-1980s and included nonsampling data collection and a site inspection (Investigation #1). Beginning in 1994, preliminary investigations were conducted that included unexploded ordnance (UXO)/high explosives (HE) and radiological surveys, and scoping sampling (Investigation #2). Finally, a radiological voluntary corrective measure (VCM) was conducted followed by post-VCM sampling (Investigation #3).

### 5.4.2 Investigation #1—Comprehensive Environmental Assessment and Response Program

#### *5.4.2.1 Nonsampling Data Collection*

The DOE CEARP Phase I report (DOE September 1987) and the Resource Conservation and Recovery Act (RCRA) Facility Assessment Report (EPA April 1987) first identified SWMU 103 as a potential release site and listed the site as "a scrap yard, located near the Building 9939 test site" that "receives a variety of debris from test activities." The CEARP report indicated "the yard could contain pieces of lead, beryllium, and/or [DU]."

#### *5.4.2.2 Sampling Data Collection*

No samples were collected during the CEARP.

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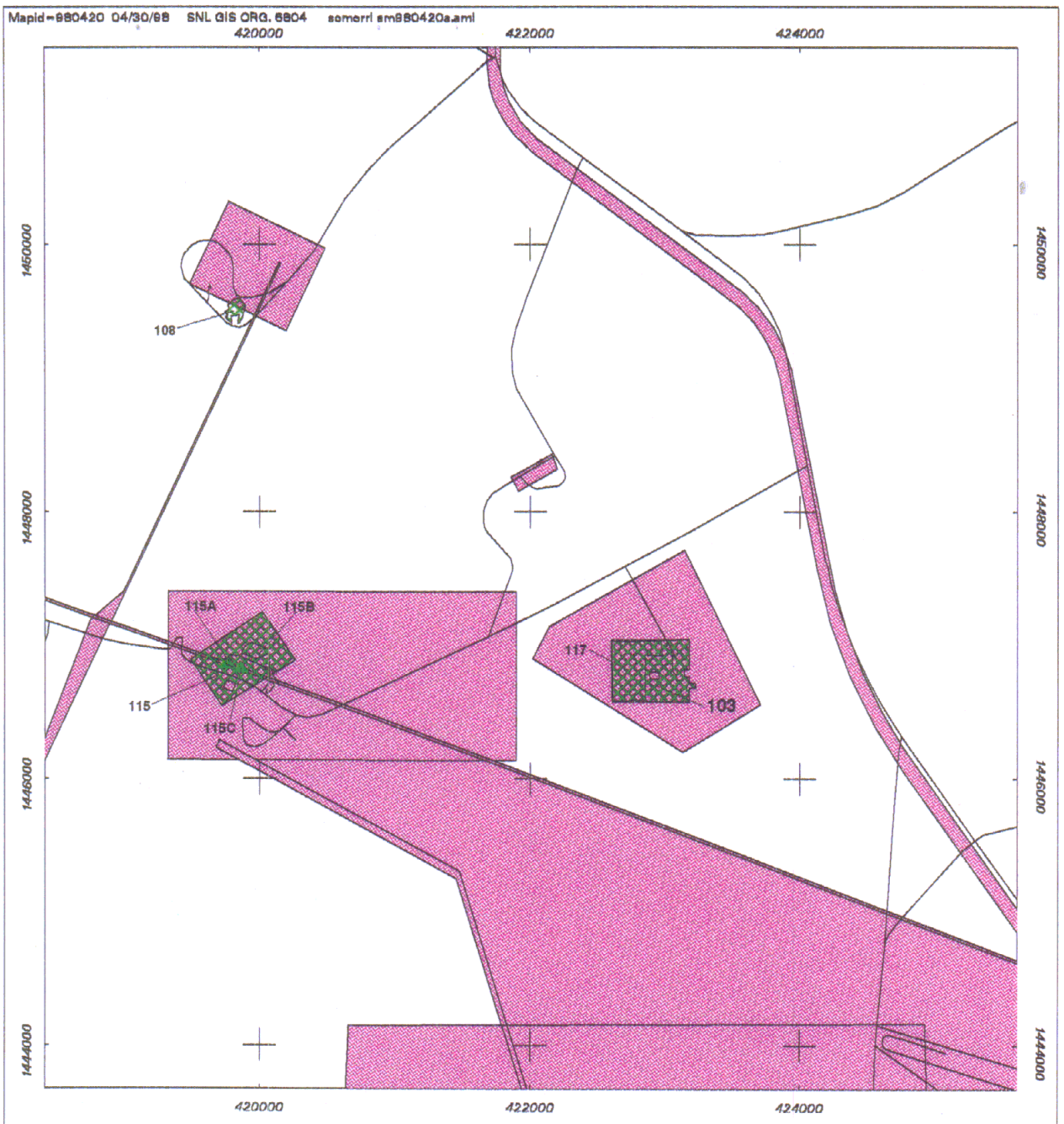



## Legend

- KAFB Boundary
- SWMUs less than one acre
- USAF Permitted to DOE/SNL
- OU 1335 SWMUs
- USAF Various Structures Within this Area Permitted to DOE/SNL/TSD/CTA Support Agreement Between USAF and DOE for Various Facilities
- Roads

**Figure 5.3.1-1**
**Current Land Use for SWMU 103**

0 600 1200
Scale in Feet

0 144 288
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

#### *5.4.2.3 Data Gaps*

No data were available to confirm whether hazardous materials or wastes were stored or released to the surrounding environment.

#### *5.4.2.4 Results and Conclusions*

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) findings were uncertain for Federal Facility Site Discovery and Identification Findings, Preliminary Assessment, and Preliminary Site Inspection. As a result, insufficient information was available to calculate a hazard ranking score.

### 5.4.3 Investigation #2—SNL/ER Preliminary Investigations

#### *5.4.3.1 Nonsampling Data Collection*

##### *5.4.3.1.1 Background Review*

A background review was conducted to collect available and relevant information regarding SWMU 103. Background information sources included interviews with SNL/NM staff and contractors who were familiar with site operational history and existing historical site records and reports. The study was completely documented and has provided traceable references that sustain the integrity of this proposal. The following lists the information sources that were used to assist in the evaluation of SWMU 103.

- Photographs and field notes from site inspections conducted by SNL/NM environmental restoration (ER) staff (Byrd November 1992)
- SNL/NM historical documents, reports, and other literature (Chu and Brockman [date unknown], Powers [date unknown], Author [Unknown], [date unknown], Keltner [date unknown], Hyde June 1992)
- Four interviews with four facility personnel (current and retired) (Powers May 1993, Wrightson October 1995a, Wrightson October 1995b, Wrightson October 1995c)

##### *5.4.3.1.2 UXO/HE Survey*

In February 1994, Kirtland Air Force Base Explosive Ordnance Disposal personnel conducted a visual surface survey for UXO/HE on the ground surface of SWMU 103. No UXO/HE or ordnance debris was identified at or in the vicinity of SWMU 103 (SNL/NM September 1994).

##### *5.4.3.1.3 Radiological Survey(s)*

In February 1990, SNL/NM's Radiation Protection Organization, Department 7714, conducted a detailed radiation and contamination survey of all the buildings and equipment associated with the Large-Scale Melt Facility. The buildings were all free of contamination, with the exception of Building 9939C, the DU crushing building, which had loose surface contamination levels of up to

3,000 disintegrations per minute (dpm)/100 square centimeters ($cm^2$) alpha and up to 10,000 dpm/100 $cm^2$ beta-gamma. This shed had already been posted as a contamination area. The following are uncontrolled items and equipment that were also found to have been contaminated:

- Expansion joint south side of Building 9947 concrete pad (Figure 5.2.2-1)
- Masonry saw (Target), south side of Building 9939D
- Pump motor (Rowland) along northern fence line
- Portable concrete pad, northwestern corner of perimeter
- Blue furnace, concrete pad, various spots
- Blue furnace, machine shed floor
- Blue furnace top landing, beige shelving unit
- Old HEPA unit rubber gasket on roof next to blue furnace
- Various soil areas inside fence perimeter
- Top outside of grated rusty welded shelf

All of the contamination that was discovered on the equipment was fixed in place, with the exception of loose residue in a masonry saw, which was nevertheless too heavy to be retained on a swipe. A sample of the dust and debris from the saw was analyzed using gamma spectroscopy and contained DU. The contaminated items were moved indoors to a posted radioactive materials management area.

Several soil areas were also found to be contaminated with DU: the pit furnace south of the office trailer, the mound of dirt south of the pit furnace, the soil around the concrete pad south of the sodium disposal pits, and the ground between Buildings 9939A and 9939B. All soil contamination areas were roped off. A significant area on and near the gravel road south of Buildings 9939A and 9939B (the sawing area where the crucibles are split after testing) was found to be contaminated (Wrightson October 1995a). Most of the DU was in chunks ranging from millimeter to bottle-cap size.

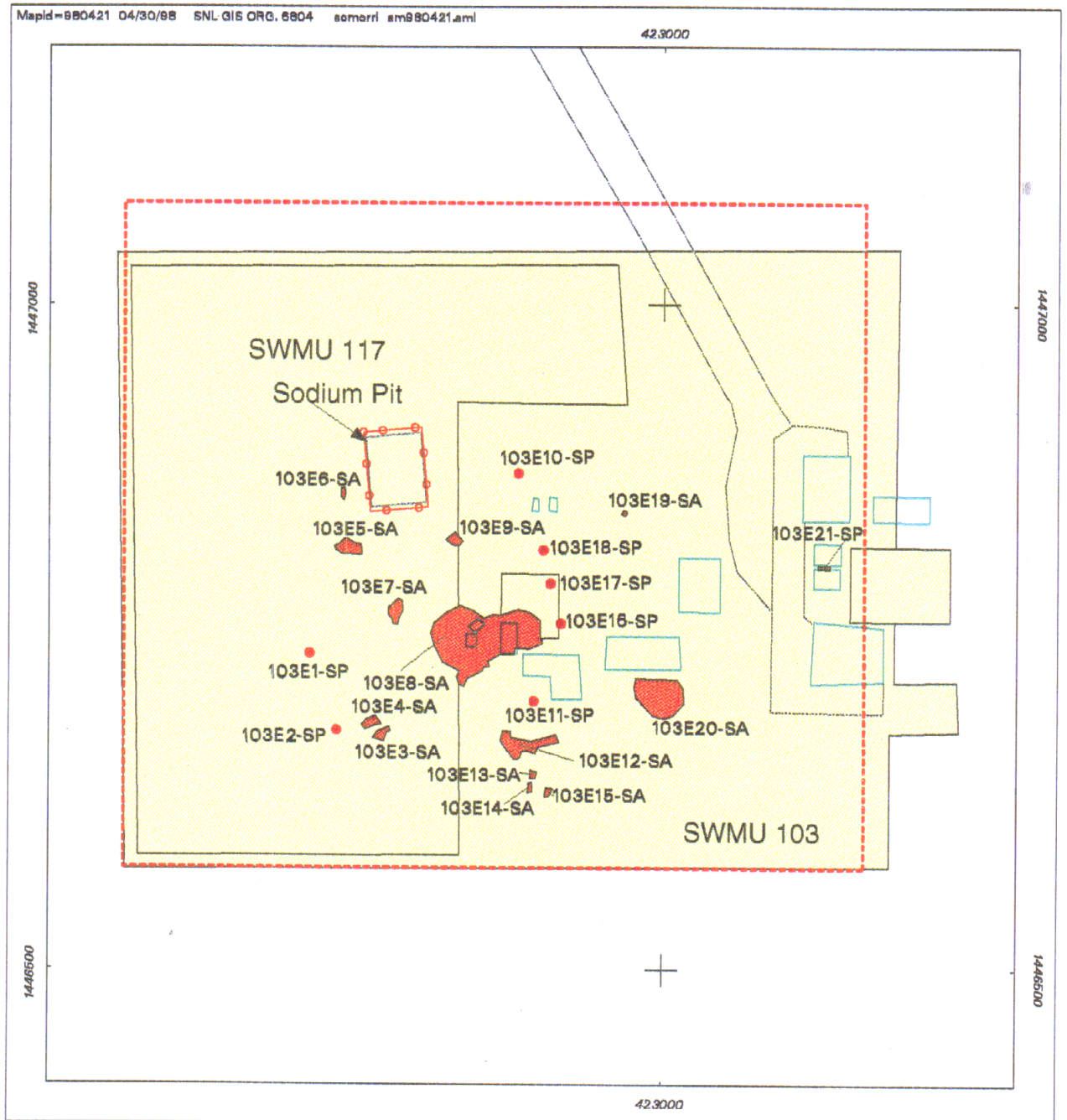
In March 1994, RUST Geotech Inc. (December 1994) conducted a surface radiation survey at SWMU 103 using sodium iodide detectors for gamma radiation. The survey covered 100 percent of the site (approximately 6 acres). Eight point-source anomalies and thirteen area-source anomalies with gamma radiation activity ranging from 13 to 198 microRoentgen/hour were located (Figure 5.4.3-1).

#### *5.4.3.1.4 Cultural-Resources Survey*

A cultural-resources survey of SWMU 103 was conducted in 1994 in support of the Environmental Assessment of the ER Project at SNL/NM (DOE March 1996). No cultural resources were identified at or in the vicinity of SWMU 103 (Hoagland and Dello-Russo February 1995).

#### *5.4.3.1.5 Sensitive-Species Survey*

A sensitive-species survey was conducted over the entire 20-acre use area associated with the Large-Scale Melt Facility (Building 9939) in 1992. No sensitive species were identified during this survey. Because the area surveyed encompassed SWMU 103, it is believed that no sensitive species occur within or adjacent to the site (IT February 1995).




## Legend

- Point Source Gamma Radiation Anomaly (Elevated relative to site specific background, SP = Soil Point)
- Road
- Building
- Radiation Survey Boundary
- Fence
- SWMU 103/117
- Area Source Gamma Radiation Anomaly (Elevated relative to site specific background, SA = Soil Area)

**Figure 5.4.3-1**
**Phase I Surface Radiation Survey at SWMU 103, March 1994**

0 60 120
Scale in Feet

0 14.4 28.8
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

### 5.4.3.2 *Sampling Data Collection*

SNL/NM conducted a scoping sampling program at SWMU 103 in July 1995. Surface soil samples were collected at the 12 locations shown in Figure 5.4.3-2. The Sampling and Analysis Plan for SWMU 103 (SNL/NM July 1995) was designed to determine if hazardous and/or radioactive materials had been released at the site. Scoping samples were collected from several areas at the site where material handling activities were conducted during test activities, including Building 9939A (location of test chamber), Building 9939C (location of DU crushing and loading operations), Building 9939D (an equipment shed), Building 9939E (radioactive waste staging building), and an area immediately south of the crucible spray pit (Figure 5.4.3-2). In addition, a single sample (103-GR-012-0-SS) was collected near the location of a suspected PCB release.

SNL/NM chain-of-custody and sample documentation procedures were followed for all scoping samples collected. All of the collected samples were analyzed for gamma-emitting radionuclides and metals. One sample (103-GR-012-0-SS) at Location 012 was also analyzed for PCB compounds because of reports of a suspected PCB release in the area. SNL/NM Department 7713, Radiation Protection Sample Diagnostics (RPSD) Laboratory, analyzed the samples on site for radionuclides using gamma spectroscopy, and SNL/NM Department 6684 (ER Chemistry Laboratory) analyzed the samples on site for metals (using U.S. Environmental Protection Agency [EPA] Method 6010/7000). At least 20 percent of the collected samples were analyzed for metals by an off-site laboratory. Lockheed Analytical Services of Las Vegas, Nevada, performed the analyses of the samples for metals (using EPA Method 6010/7000). This NFA proposal discusses the eight RCRA metals plus beryllium and nickel. The analysis for PCB compounds was also performed off site by Lockheed Analytical Services of Las Vegas, Nevada (using EPA Method 8080).

### 5.4.3.3 *Data Gaps*

Information gathered through process knowledge, review of historical site files, and personal interviews aided in identifying the most likely COCs, the most likely locations of potential releases of COCs, and the types of analyses to perform on soil samples. Radiological surveys and scoping sampling defined the location and extent of contamination at SWMU 103. However, because the need to remove elevated concentrations of radiological contamination was identified, residual contamination levels that might remain after cleanup activities could not be defined.

### 5.4.3.4 *Results and Conclusions*

In July 1995, representative surface soil samples were collected from 12 locations at SWMU 103. Tables 5.4.3-1, 5.4.3-2, and 5.4.3-3 summarize the metals, gamma spectroscopy, and PCB analytical results, respectively, for the scoping sampling program conducted at SWMU 103. An example soil sample identification (ID) contained in the ER Sample ID is "103-GR-001-0-SS." This ID refers to SWMU "103," grab sample type "GR," sample location "001," sample depth beginning at "0" feet (surface), soil sample media "SS." Complete results of the gamma spectroscopy analyses are contained in Annex 5-A. This section briefly describes those results.

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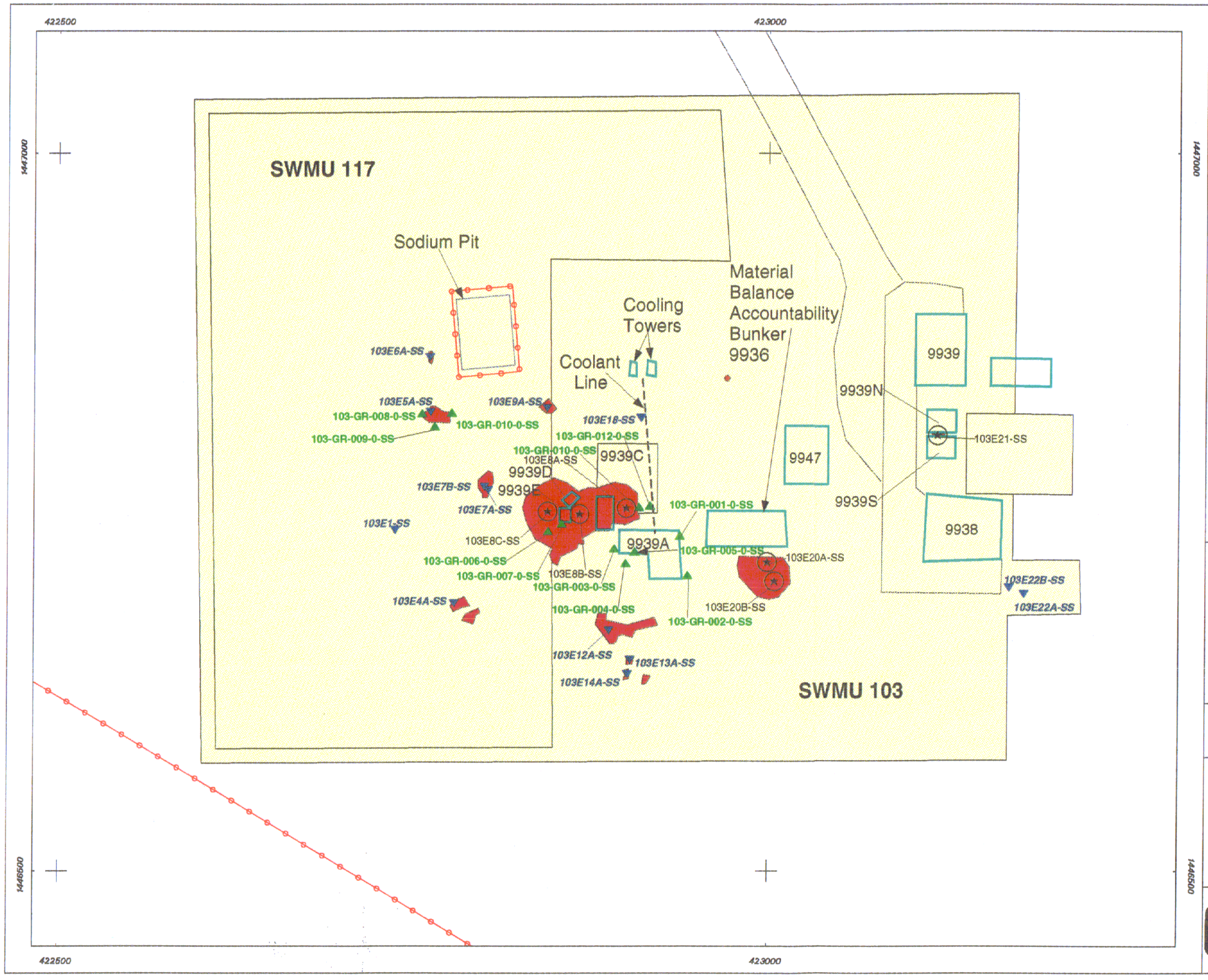


## Legend

- 103-GR-012-0-SS — Scoping Sample Location
- 103E6A-SS — Post-cleanup (Verification) Soil Sample Location
- 103E21-SS — Pre-cleanup Soil Sample Location (Final determination)
- Road
- Fence
- Building
- SWMU 103/117
- Area Source Gamma Radiation Anomaly from Phase I Survey

0 75 150
Scale in Feet

0 20 40
Scale in Meters

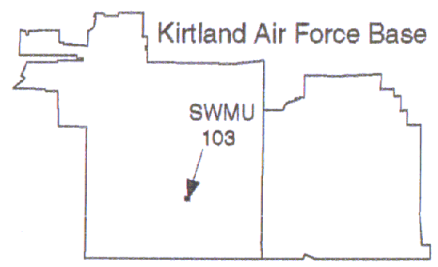


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**Figure 5.4.3-2**
**SWMU 103**
**VCM Sample Locations**

*Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1927 North American Horizontal Datum, 1929 North American Vertical Datum*

| | | |
|---|---|---|
| | 1:900 | MAPID=980423 |
| Unclassified | | SNL GIS ORG. 6804 |
| SMorrison | sm980423.aml | 04/30/98 |

# Table 5.4.3-1
## Summary of SWMU 103 Scoping Soil Sampling Metals Analysis Results, July 1995

| Sample Attributes | | | Metals (EPA 6010/7000) (mg/kg)[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Record Number[b] | ER Sample ID (Figure 5.4.3-2) | Sample Depth (ft) | Arsenic | Barium | Beryllium | Cadmium | Chromium | Mercury | Nickel | Lead | Selenium | Silver |
| 508933 | 103-GR-001-0-SS | 0–0.5 | ND (50) | 190 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | 16 J (38) | ND (50) | ND (10) |
| 508933 | 103-GR-002-0-SS | 0–0.5 | ND (50) | 150 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | 28 J (38) | ND (50) | ND (10) |
| 508933 | 103-GR-003-0-SS | 0–0.5 | ND (50) | 170 | ND (0.11) | ND (10) | 27 J (38) | ND (0.06) | ND (4.0) | 25 J (38) | ND (50) | ND (10) |
| 508933 | 103-GR-004-0-SS | 0–0.5 | ND (50) | 79 | ND (0.11) | ND (10) | 220 | ND (0.06) | ND (4.0) | 52 | ND (50) | ND (10) |
| 508933 | 103-GR-005-0-SS | 0–0.5 | ND (50) | 180 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | ND (10) | ND (50) | ND (10) |
| 508933 | 103-GR-006-0-SS | 0–0.5 | ND (50) | 130 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | ND (10) | ND (50) | ND (10) |
| 508933 | 103-GR-007-0-SS | 0–0.5 | ND (50) | 160 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | ND (10) | ND (50) | ND (10) |
| 508933 | 103-GR-008-0-SS | 0–0.5 | ND (50) | 87 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | ND (10) | ND (50) | ND (10) |
| 508933 | 103-GR-009-0-SS | 0–0.5 | ND (50) | 130 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | ND (10) | ND (50) | ND (10) |
| 508933 | 103-GR-010-0-SS | 0–0.5 | ND (50) | 64 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | 10 J (38) | ND (50) | ND (10) |
| 508933 | 103-GR-010-0-D | 0–0.5 | ND (50) | 77 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | ND (10) | ND (50) | ND (10) |
| 508933 | 103-GR-011-0-SS | 0–0.5 | ND (50) | 90 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | ND (10) | ND (50) | ND (10) |
| 508933 | 103-GR-012-0-SS | 0–0.5 | ND (50) | 170 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | ND (10) | ND (50) | ND (10) |
| 508933 | 103-GR-012-0-D | 0–0.5 | ND (50) | 140 | ND (0.11) | ND (10) | ND (10) | ND (0.06) | ND (4.0) | ND (10) | ND (50) | ND (10) |
| 03981 | 103-GR-012-0-SS (off-site laboratory) | 0–0.5 | 3.2 | 93 | ND (1.0) | ND (1.0) | 9.1 | ND (0.10) N* | 8.2 | 5.7 N | ND (1.0) | ND (2.0) |
| 03981 | 103-GR-012-0-SS (off-site laboratory) | 0–0.5 | 4.3 S | 180 | ND (1.0) | 1.9 | 8.8 | ND (0.10) N* | ND (8.3) | 5.0 N | ND (1.1) | ND (2.1) |
| 03981 | 103-GR-012-0-SS (off-site laboratory) | 0–0.5 | 6.4 S | 220 | ND (1.0) | 3.9 | 34. | ND (0.092) N* | 24. | 910 N | ND (1.0) | ND (2.0) |
| 03981 | 103-GR-012-0-SSD (off-site laboratory) | 0–0.5 | 4.1 | 130 | ND (1.0) | ND (1.0) | 6.9 | ND (0.11) N* | ND (8.2) | 9.2 N | ND (1.0) | ND (2.1) |
| Quality Assurance/Quality Control Samples (all in mg/L) | | | | | | | | | | | | |
| 508933 | 103-GR-012-0-FB | NA | ND (0.50) | ND (0.10) | ND (0.011) | ND (0.10) | ND (0.10) | NT | ND (0.04) | ND (0.10) | ND (0.50) | ND (0.10) |
| 508933 | 103-GR-012-0-R | NA | ND (0.50) | ND (0.10) | ND (0.011) | ND (0.10) | ND (0.10) | NT | ND (0.04) | ND (0.10) | ND (0.50) | ND (0.10) |
| 03981 | 103-012-R (off-site laboratory) | NA | ND (0.010) | ND (0.20) | ND (0.0050) | ND (0.0050) | ND (0.010) | ND (0.00020) | ND (0.040) | ND (0.0030) | ND (0.0050) | ND (0.010) |
| 03981 | 103-012-FB (off-site laboratory) | NA | ND (0.010) | ND (0.20) | ND (0.0050) | ND (0.0050) | ND (0.010) | ND (0.0020) | ND (0.040) | ND (0.0030) | ND (0.0050) | ND (0.010) |
| 03981 | 103-012-RD (off-site laboratory) | NA | ND (0.010) | ND (0.20) | ND (0.0050) | ND (0.0050) | ND (0.010) | ND (0.00020) | ND (0.040) | ND (0.0030) | ND (0.0050) | ND (0.010) |

Refer to footnotes at end of table.

## Table 5.4.3-1 (Concluded)
## Summary of SWMU 103 Scoping Soil Sampling Metals Analysis Results, July 1995

| Sample Attributes | | | Metals (EPA 6010/7000) (mg/kg)[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Record Number[b] | ER Sample ID (Figure 5.4.3-2) | Sample Depth (ft) | Arsenic | Barium | Beryllium | Cadmium | Chromium | Mercury | Nickel | Lead | Selenium | Silver |
| 03981 | 103-012-FBD (off-site laboratory) | NA | ND (0.010) | ND (0.20) | ND (0.0050) | ND (0.0050) | ND (0.010) | ND (0.00020) | ND (0.040) | ND (0.0030) | ND (0.0050) | ND (0.010) |
| HRMB Maximum Background Surface Soil Concentrations—Southwest Area[c] | | | 5.6 | 130 | 0.65 | <1 | 17.3 | <0.25 | 11.5 | 21.4 | <1 | <1 |

[a]EPA November 1986.
[b]Analysis request/chain of custody record.
[c]Dinwiddie September 24, 1997.

D,SSD = Duplicate surface soil sample.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
FB, FBD = Field blank, field blank duplicate.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J ( ) = The estimated value reported is either above the highest calibration standard or less than the practical quantification limit, shown in parenthesis.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
N = Matrix spike recovery exceeded acceptance limits.
N* = Matrix spike recovery exceeded acceptance limits and the relative percent difference for the duplicate analysis exceeded acceptance limits.
NA = Not applicable.
ND ( ) = Not detected at or above the method detection limit for on-site laboratory analyses or project reporting limit for off-site laboratory analyses, shown in parenthesis.
NT = Not tested.
R, RD = Equipment blank, equipment blank duplicate.
S = Reported value was determined from the method of standard addition.
SNL/NM = Sandia National Laboratories/New Mexico.
SS = Surface soil sample.
SWMU = Solid waste management unit.
SWTA = Southwest Test Area.
UTL = Upper tolerance limit.

# Table 5.4.3-2
## Summary of SWMU 103 Scoping Soil Sampling Gamma Spectroscopy Analysis Results, July 1995

| Sample Attributes | | | Activity (pCi/g) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Record Number[a] | ER Sample ID (Figure 5.4.3-2) | Sample Depth (ft) | Uranium-238 | Thorium-234 | Thorium-232 | Radium-228 | Thorium-228 | Uranium-235 | Cesium-137 | Cobalt-60 |
| 03678 | 1335-103-GR-001-0-SS | 0–0.5 | ND (5.58) | 2.14E+00 | 6.72E-01 | 4.84E-01 | 6.65E-01 | ND (3.71E-01) | 3.72E-02 | ND (5.85E-02) |
| 03678 | 1335-103-GR-002-0-SS | 0–0.5 | 4.04E+01 | 4.30E+01 | 4.37E-01 | 3.86E-01 | ND (2.19) | ND (8.56E-01) | ND (9.04E-02) | ND (6.26E-02) |
| 03678 | 1335-103-GR-003-0-SS | 0–0.5 | 3.41E+01 | 3.92E+01 | 4.97E-01 | 5.51E-01 | 5.85E-01 | 6.37E-01 | 3.77E-02 | 1.93E-01 |
| 03678 | 1335-103-GR-004-0-SS | 0–0.5 | 1.80E+01 | 2.42E+01 | 7.49E-01 | 7.36E-01 | ND (1.33) | ND (4.84E-01) | ND (5.80E-02) | ND (6.02E-02) |
| 03678 | 1335-103-GR-005-0-SS | 0–0.5 | 9.26 | 1.17E+01 | 4.46E-01 | 2.50E-01 | 7.95E-01 | ND (4.59E-01) | ND (5.64E-02) | ND (5.18E-02) |
| 03678 | 1335-103-GR-006-0-SS | 0–0.5 | ND (5.64) | 2.27 | 4.73E-01 | 3.05E-01 | ND (1.29) | ND (3.98E-01) | ND (6.12E-02) | ND (6.73E-02) |
| 03678 | 1335-103-GR-007-0-SS | 0–0.5 | 1.28E+02 | 1.87E+02 | 3.28E-01 | 5.13E-01 | ND (2.57) | 2.35 | 4.06E-02 | ND (7.51E-02) |
| 03678 | 1335-103-GR-008-0-SS | 0–0.5 | ND (5.79) | ND (7.18E-01) | 5.48E-01 | 9.21E-01 | 6.22E-01 | ND (4.31E-01) | ND (6.41E-02) | ND (6.78E-02) |
| 03678 | 1335-103-GR-009-0-SS | 0–0.5 | 1.46E+01 | 1.53E+01 | 5.61E-01 | 5.40E-01 | 7.09E-01 | ND (4.18E-01) | 9.21E-02 | ND (5.32E-02) |
| 03678 | 1335-103-GR-010-0-SS | 0–0.5 | ND (5.84) | 1.40 | 7.67E-01 | 7.91E-01 | 1.05 | ND (4.23E-01) | ND (6.18E-02) | ND (7.15E-02) |
| 03678 | 1335-103-GR-010-0-SSD | 0–0.5 | ND (5.69) | ND (1.30) | 5.80E-01 | 6.62E-01 | 8.21E-01 | ND (4.06E-01) | ND (5.76E-02) | ND (6.79E-02) |
| 03678 | 1335-103-GR-011-0-SS | 0–0.5 | 2.66E+01 | 2.67E+01 | 5.11E-01 | 4.95E-01 | ND (1.41) | ND (5.57E-01) | ND (6.47E-02) | ND (5.24E-02) |
| 03678 | 1335-103-GR-012-0-SS | 0–0.5 | ND (5.22) | ND (1.21) | 4.15E-01 | 5.00E-01 | ND (1.19) | ND (3.78E-01) | 4.96E-02 | ND (5.76E-02) |
| 03678 | 1335-103-GR-012-0-SS1-D | 0–0.5 | ND (5.76) | 1.20 | 5.89E-01 | 3.06E-01 | 7.43E-01 | ND (3.92E-01) | 4.90E-02 | ND (5.76E-02) |
| Quality Assurance/Quality Control Samples (all in pCi/L). | | | | | | | | | | |
| 03678 | 1335-103-GR-012-R | NA | ND (1.61) | ND (3.79E-01) | ND (1.24E-01) | ND (1.15E-01) | ND (4.36E-01) | ND (1.53E-01) | ND (2.13E-02) | ND (2.43E-02) |
| 03678 | 1335-103-GR-012-RD | NA | ND (1.56) | ND (3.67E-01) | ND (1.24E-01) | ND (1.26E-01) | ND (4.34E-01) | ND (1.46E-01) | ND (2.02E-02) | ND (2.30E-02) |
| 03678 | 1335-103-GR-012-FB | NA | ND (1.61) | ND (3.67E-01) | ND (1.19E-01) | ND (1.25E-01) | ND (4.44E-01) | ND (1.48E-01) | ND (2.33E-02) | ND (2.49E-02) |
| 03678 | 1335-103-GR-012-FBD | NA | ND (1.58) | ND (3.81E-01) | ND (1.18E-01) | ND (1.21E-01) | ND (4.23E-01) | ND (1.45E-01) | ND (2.00E-02) | ND (2.14E-02) |
| HRMB Maximum Background Surface Soil Concentrations—Southwest Area[b] | | | 1.4 | 1.4 | 1.01 | 1.01 | 1.01[c] | 0.16 | 0.664 | Not available |

[a]Analysis request/chain of custody record.
[b]Dinwiddie September 24, 1997.
[c]Brown January 14, 1998.
D,SSD = Duplicate surface soil sample.
ER = Environmental Restoration.
FB, FBD = Field blank, field blank duplicate.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
NA = Not applicable.
ND ( ) = Not detected at or above the minimum detectable activity, shown in parenthesis.
pCi/g = Picocurie(s) per gram.
pCi/L = Picocurie(s) per liter.
R, RD = Equipment blank, equipment blank duplicate.
SNL/NM = Sandia National Laboratories/New Mexico
SS = Surface soil sample.
SWMU = Solid waste management unit.
SWTA = Southwest Test Area.
UTL = Upper tolerance limit.

# Table 5.4.3-3
## Summary of SWMU 103 Scoping Soil Sampling PCB Analysis Results, July 1995
## (Off-Site Laboratory Only)

| Sample Attributes | | | PCB (EPA 8080) (µg/kg)[a] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Record Number[b] | ER Sample ID (Figure 5.4.3-2) | Sample Depth (ft) | PCB-1016 | PCB-1221 | PCB-1232 | PCB-1242 | PCB-1248 | PCB-1254 | PCB-1260 |
| 03981 | 103-012-0-SS-10 | 0–0.5 | ND (13.) | ND (13.) | ND (13.) | ND (13.) | ND (13.) | ND (13.) | 9.3 J (13.) |
| 03981 | 103-012-0-SS-11 | 0–0.5 | ND (13.) | ND (13.) | ND (13.) | ND (13.) | ND (13.) | ND (13.) | 12. J (13.) |
| Quality Assurance/Quality Control Samples (all in µg/L) | | | | | | | | | |
| 03981 | 103-GR-012-R | NA | ND (1.0) | ND (2.0) | ND (1.0) | ND (1.0) | ND (1.0) | ND (1.0) | ND (1.0) |
| 03981 | 103-GR-012-RD | NA | ND (1.0) | ND (2.0) | ND (1.0) | ND (1.0) | ND (1.0) | ND (1.0) | ND (1.0) |
| 03981 | 103-GR-012-FB | NA | ND (1.0) | ND (2.0) | ND (1.0) | ND (1.0) | ND (1.0) | ND (1.0) | ND (1.0) |

[a]EPA November 1986.
[b]Analysis request/chain of custody record.

µg/kg = Milligram(s) per kilogram.
µg/L = Milligram(s) per liter.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
FB = Field blank.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J ( ) = Estimated value detected at a level less than the PQL, shown in parenthesis, and greater than or equal to the method detection limit.
NA = Not applicable.
ND ( ) = Not detected at or above the PQL, shown in parenthesis.
PCB = Polychlorinated biphenyls.
PQL = practical quantitation limit.
R, RD = Equipment blank, equipment blank duplicate.
SS = Surface soil sample.
SWMU = Solid waste management unit.

The minimum detection limits (MDL) for all on-site analyses of metals exceeded the background concentration limits for arsenic, cadmium, selenium, and silver. The off-site laboratory provided a lower MDL for metals analyses of split samples; however, the MDL for cadmium, selenium, and silver is very close to background concentration. The cadmium MDL is 1.1 milligrams per kilogram (mg/kg) as compared to the background concentration limit of less than 1.0 mg/kg. The selenium MDL is 1.0 mg/kg as compared to the background concentration limit of less than 1.0 mg/kg. The silver MDL ranges from 2.0 to 2.1 mg/kg as compared to the background concentration limit of less than 1.0 mg/kg. In general, the lower MDL of the off-site split samples compares to the background concentration limits.

Metals

Table 5.4.3-1 presents a summary of the metals analysis results for the 12 surface soil samples, 2 duplicate samples, and 4 split samples collected during the scoping sampling program at SWMU 103. Concentrations of beryllium, mercury, selenium, and silver were not detected in any samples. Barium concentrations were detected above background levels in nine samples. Chromium was detected significantly above the background concentration limit in sample 103-GR-004-SS and slightly above the background limit in sample 103-GR-003-0-SS. Similarly, lead was detected significantly above the background concentration limit in sample 103-GR-004-SS and only slightly above the background limit in samples 103-GR-002-SS and 103-GR-003-SS.

Samples 103-GR-012-0-SS and a duplicate were collected for on-site analysis. In addition, both of these were also split for off-site analysis. Split sample 103-GR-012-0-SS consists of three fractions. The results obtained from the off-site analysis of the sample splits indicate that arsenic, cadmium, chromium, nickel, and lead exceeded the background concentration limits in one or more of the split fractions. However, in each instance the remaining off-site analyses of the split fractions and split duplicate, and the on-site analysis of the sample and duplicate, do not validate the presence of arsenic, cadmium, chromium, nickel, and lead above background levels at this sample location. Given the particulate nature of COCs at the site, it is highly probable that sample fractions from the same location contain variable amounts of metal fragments. It should be noted that comparison to on-site laboratory results for arsenic, cadmium, and chromium is limited because the MDLs used for these analyses were above background concentration limits.

Radionuclides

Table 5.4.3-2 presents a summary of the on-site gamma spectroscopy analysis results for the 12 surface soil samples and 2 duplicate samples collected during the scoping sampling program at SWMU 103. Scoping samples 103-GR-001-0-SS through 103-GR-005-0-SS were collected around the perimeter of Building 9939A (see Figure 5.4.3-2). These five sample locations do not correspond to any of the point or area sources identified during the March 1994 surface radiation survey. Gamma activity from uranium-238 and/or the short-lived daughter thorium-234 was above the background concentration limit in each of these five samples. Gamma activity from uranium-235 exceeded the background limit in only one sample (103-GR-003-0-SS). However, the minimum detectable activity (MDA) of uranium-235 for the remaining four samples exceeded background levels. However, this does not present a problem because

the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based preliminary remediation goal (PRG), which is based upon a 15-millirem-per-year effective dose equivalent (EDE) maximum dose limit found in EPA's OSWER Directive No. 9200.4-18, "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA 1997a). Therefore, the analytical results are acceptable. Although no background limit exists for comparison, gamma activity from cobalt-60 was detected at a very low concentration in sample 103-GR-003-0-SS. Based upon the experiments conducted and the materials used at SWMU 103, the source of the detected cobalt-60 is unknown. Gamma activity from thorium-232, radium-228, thorium-228, and cesium-137 was not detected above the background activity levels or the MDA exceeded the background limits in these five samples.

Scoping samples 103-GR-008-0-SS through 103-GR-010-0-SS were collected around the perimeter of the radiological area source 103E5 (see Figure 5.4.3-2), which was identified during the March 1994 Phase I radiation survey. At these three sample locations gamma activity from uranium-238 and the short-lived daughter thorium-234 was detected above the background limit in sample 103-GR-009-0-SS, and the MDA for uranium-238 and thorium-234 exceeded the background limits in samples 103-GR-008 and -009. Gamma activity from thorium-232, radium-228, thorium-228, uranium-235, and cesium-137 was not detected above the background concentration limits or the MDA exceeded the background limits in these three samples, with one exception: gamma activity was detected slightly above the background activity levels for thorium-228 in sample 103-GR-010-0-SS.

Scoping samples 103-GR-006-0-SS, 103-GR-007-0-SS, 103-GR-011-0-SS, and 1103-GR-012-0-SS were collected within the radiological area source 103E8 (see Figure 5.4.3-2), which was identified during the March 1994 Phase I radiation survey. Gamma activity from thorium-232, radium-228, thorium-228, and cesium-137 was not detected above background concentration limits or the MDA exceeded the background limits. Gamma activity from uranium-238, thorium-234, and uranium-235 was significantly elevated above the background concentration limits in sample 103-GR-007-0-SS. Similarly, gamma activity from uranium-238 and thorium-234 was also significantly elevated above background activity levels in sample 103-GR-011-0-SS.

PCBs

Table 5.4.3-3 presents a summary of the PCB analysis results for the two surface soil samples fractions collected from sampling location 103-GR-012-0-SS during the scoping sampling program at SWMU 103. An estimated concentration of 9.3 *J* µg/kg and 12 *J* µg/kg of PCB Arochlor-1260 was detected in the two fractions. No other PCB compounds were detected at or above the practical quantitation limit.

Quality Assurance/Quality Control Results

Tables 5.4.3-1 and 5.4.3-3 presents result of the analysis of metals and PCB quality assurance and quality control (QA/QC) samples that were collected during the scoping sampling program at SWMU 103. Two QA/QC samples (a field and an equipment blank) were collected for on-site analyses of metals. The two QA/QC samples were also split for off-site analysis of metals and PCBs. In addition, duplicate field and equipment blank samples were prepared for off-site

analysis of metals and PCBs. The duplicate field blank was received broken by the off-site laboratory; therefore, no analyses could be performed on the sample. However, analytical results for the remaining QA/QC samples indicated that no metals or PCBs were detected. Metals analyses of split samples were verified off site.

Two duplicate samples (103-GR-010-0-D and 103-GR-012-0-D) were collected during the scoping sampling program at SWMU 103 and were analyzed on site for metals. The maximum relative percent difference (RPD) for barium (only metal detected in duplicates) was 19 percent. In addition, two split samples (103-GR-012-0-SS and 103-GR-012-0-SSD) were collected during the scoping sampling program at SWMU 103 and were analyzed for metals off site for verification. As noted previously, split sample 103-GR-012-0-SS consisted of three fractions. The RPDs for all metals ranged from 44 percent (arsenic) to over 100 percent for chromium and lead. Given the particulate nature of COCs at the site, it is likely that the anomalously high concentrations in one aliquot reflect particles of metallic slag contained in the sample. The apparent lack of precision is more likely related to variability in composition of the sample fractions. Results obtained for the split samples were described in Section 5.4.3.4.

Table 5.4.3-2 presents results of the analysis of radionuclides in QA/QC samples that were collected during the scoping sampling program at SWMU 103. All QA/QC analyses for radionuclides were performed on site. Two QA/QC samples were collected (a field and an equipment blank) as were duplicates for each. Results for these QA/QC sample analyses showed no gamma activity.

Two duplicate samples (103-GR-010-0-SSD and 103-GR-012-0-SS1-D) were collected during the scoping sampling program at SWMU 103 and were analyzed on-site for radionuclides using gamma spectroscopy. Concentration levels of radionuclides in the duplicate samples were comparable to those detected in the equivalent primary samples.

Data Validation

All off-site data were reviewed and verified/validated by the SNL/NM Sample Management Office according to "Data Verification/Validation Level 2—DV-2" in Attachment B of the Technical Operating Procedure 94-03, Rev.0 (SNL/NM July 1994). All gamma spectroscopy data were reviewed by SNL/NM Department 7713 in accordance with the RPSD Procedure RPSD-02-11 (SNL/NM July 1996). The verification/validation process confirmed that the data are acceptable for use in this NFA proposal for SWMU 103.

## 5.4.4 Investigation #3—SNL/NM ER Project Voluntary Corrective Measure and Confirmatory Sampling

### *5.4.4.1 Sampling Data Collection*

#### *5.4.4.1.1 Voluntary Corrective Measure Activities*

A radiological VCM was conducted at SWMU 103 during March 1995, from July through September 1995, and during June 1996 (SNL/NM September 1997). VCM activities focused on the 8 point sources and 13 area sources identified in the March 1994 Phase I radiation survey (see Figure 5.4.3-1).

Pre-Rad VCM Sampling

Pre-VCM soil samples from one point source (103E21) and seven area sources (103E5, 103E6, 103E7, 103E8, 103E9, 103E19, and 103E20) were collected to determine whether remediation would be required. The samples were analyzed on site at SNL/NM Department 7713 (RPSD Laboratory) for gamma-emitting radionuclides by using gamma spectroscopy. Results of the analysis indicated that remediation would be required neither at point source 103E21 nor at area sources 103E8 and 103E20 because elevated gamma levels detected during the Phase I survey were related to "shine" (gamma interference) from material stored in nearby buildings (SNL/NM September 1997). It was determined that another point source (103E2) was associated with a concrete cylinder and, therefore, was not remediated (SNL/NM September 1997).

As a result of pre-VCM sampling, all but two point sources and two area sources identified during the Phase I radiation survey were remediated. During the initial VCM activities a new area source (103E22) was identified and remediated. Manual cleanup procedures were followed to remove all point and area source anomalies except for area source 103E12. A skidloader was used to remediate this area source because the lateral and vertical extent of elevated radiation exceeded manual capabilities.

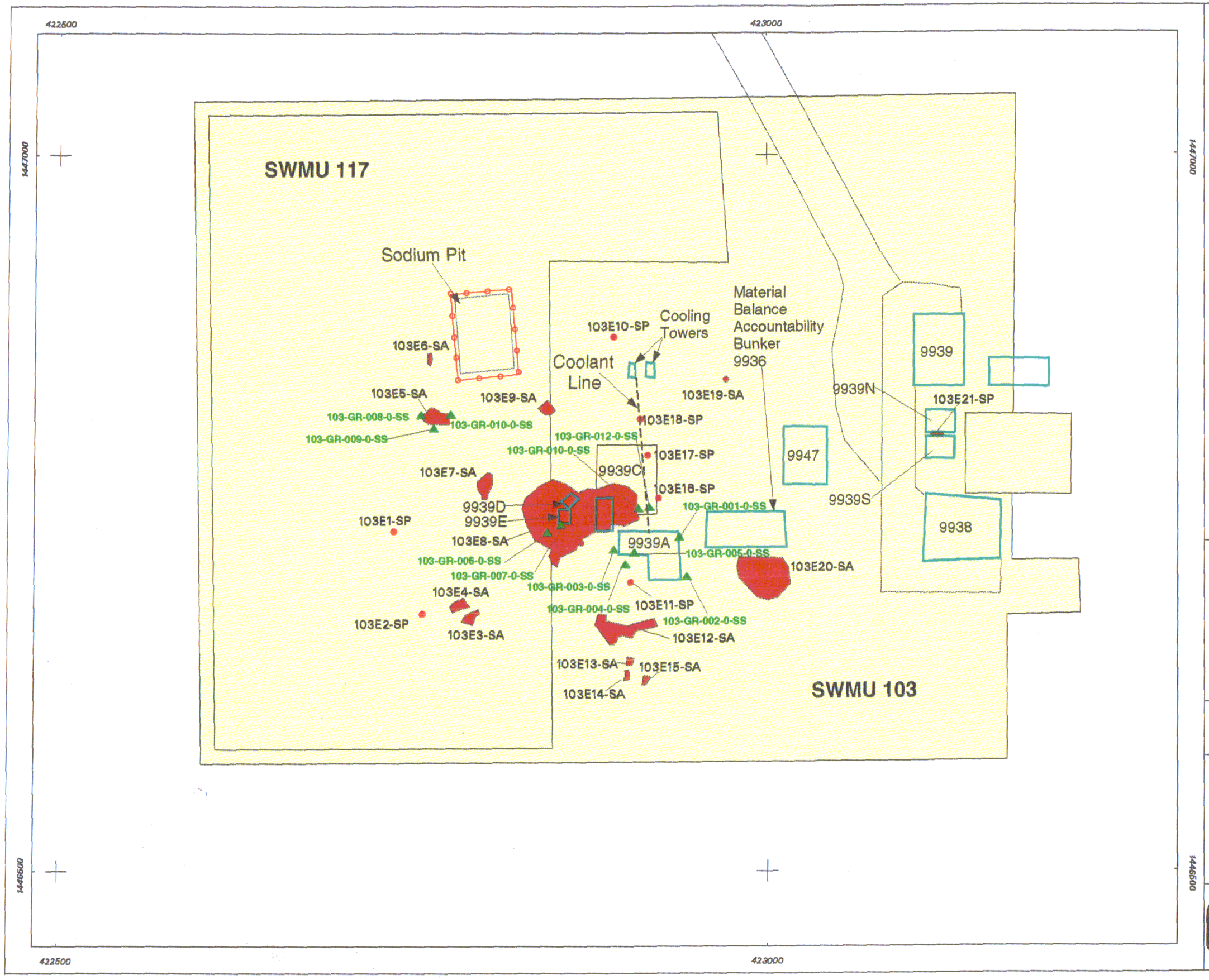
Post-Rad VCM Sampling

Following cleanup activities at SWMU 103, post-VCM verification samples were collected from the former locations of two point sources (103E1 and 103E18) and nine area sources (103E4, 103E5, 103E6, 103E7, 103E9, 103E12, 103E13, 103E14, and 103E22). Figure 5.4.4-1 shows the radiation anomalies identified in the Phase I radiation survey, post-VCM verification sample locations, and pre-VCM sample locations where no remediation was required. Post-VCM verification samples were not collected at the former locations of four point sources (103E10, 103E11, 103E16, and 103E17) because the VCM sampling procedures required collecting from only 10 percent of remediated point sources (SNL/NM September 1997). Two post-VCM verification samples that were collected near area sources 103E13 and 103E14 were also considered representative of area source 103E15 (see Figure 5.4.4-1). A post-VCM verification sample was not obtained from area source 103E19.

Post-VCM verification samples were collected near point sources and from areas exhibiting the highest residual gamma radiation readings at area sources. SNL/NM Department 7713 (RPSD Laboratory) analyzed the post-VCM verification samples on site for gamma-emitting radionuclides using gamma spectroscopy. No other analyses were performed on the VCM samples.

### *5.4.4.2 Data Gaps*

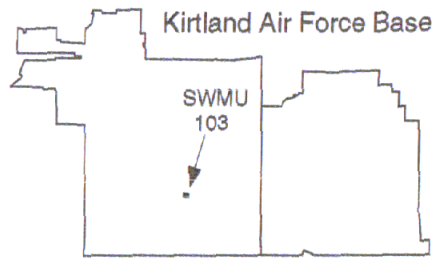
No data gaps in site characterization exist at SWMU 103. Although a complete history of past releases at the site is incomplete, analytical data from radiological screening, scoping sampling, and VCM sampling are sufficient to determine whether significant releases of COCs occurred at the site.




## Legend

- 103-GR-012-0-SS — Scoping Sample Location
- 103E18-SP — Point Source Gamma Radiation Anomaly (Elevated relative to site specific background, SP = Soil Point)
- Road
- Fence
- Building
- SWMU 103/117
- Area Source Gamma Radiation Anomaly from Phase I Survey

0 75 150
Scale in Feet
0 20 40
Scale in Meters




Sandia National Laboratories, New Mexico
Environmental Geographic Information System

**Figure 5.4.4-1**
**SWMU 103**
**Scoping Sample Locations**

*Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1927 North American Horizontal Datum, 1929 North American Vertical Datum*

| | | |
|---|---|---|
| | 1:900 | MAPID=980422 |
| Unclassified | | SNL GIS ORG. 6804 |
| SMorrison | sm980422.aml | 04/30/98 |

### *5.4.4.3 Results and Conclusions*

Table 5.4.4-1 summarizes the gamma spectroscopy analysis results for the 13 post-VCM verification samples and the 5 pre-VCM samples from locations that did not require remediation. Complete results of the gamma spectroscopy analyses are contained in Annex 5-A. Gamma activity from thorium-232, radium-228, thorium-228, and cesium-137 were not detected above the background concentration limits in any samples. Gamma activity from cobalt-60 was not detected in any of the pre- and post-VCM samples collected. Gamma activity from uranium-235 was detected above the background concentration limit in sample 103E1-SS and the duplicate sample 103E7B-SS. Although uranium-235 was not detected in the remaining samples, the MDAs used in those analyses were above the background concentration limit. Therefore, a comprehensive comparison to background concentration limits of uranium-235 is not possible. This does not present a problem because the MDA is still several orders of magnitude less than the projected PRG for uranium-235 at this site.

The MDAs used in the analyses for uranium-238 were also above the background concentration limits. As a result, a comprehensive comparison to background for uranium-238 is not possible. Although the MDA for gamma-emitting radionuclides was sometimes higher than the background level for that radionuclide, they were nevertheless orders of magnitude less than a risk-based PRG, which is based upon a 15-millirem-per-year EDE maximum dose limit found in "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination" (EPA 1997a). Therefore, the analytical results are acceptable. However, because the MDAs used in the analyses for thorium-234 (short-lived daughter of uranium-238) are at or below the background concentration limits, gamma activity from this isotope can be used to confirm or refute nondetects for uranium-238. Specifically, gamma activity from thorium-234 that is above the background concentration limit can be used as an indication that uranium-238 might exceed background also. On this basis, gamma activity from both uranium-238 and thorium-234 are considered above background limits in two pre-VCM samples (103E20A-SS and 103E8C-SS) and nine post-VCM verification samples (103E1-SS, 103E5A-SS, 103E6A-SS, 103E7A-SS, 103E7B-SS, 103E9A-SS, 103E12A-SS, 103E22A-SS, and 103E22B SS).

Quality Assurance/Quality Control Results

Table 5.4.4-1 presents results of the analyses of radionuclides in QA/QC samples that were collected during the VCM sampling program at SWMU 103. Two duplicate samples were collected for on-site analysis using gamma spectroscopy (103E7B-SS and 103E22B-SS). Results obtained for the duplicate samples were consistent with the primary samples, except for concentrations of uranium-238 and thorium-234. Both duplicate samples showed higher concentrations of uranium-238 and thorium-234.

Data Validation

All gamma spectroscopy results were reviewed by SNL/NM Department 7713 according to the RPSD Procedure RPSD-02-11 (SNL/NM July 1996). The process confirmed that the data were valid for use in this proposal.

# Table 5.4.4-1
## Summary of SWMU 103 Soil Radiological VCM Results, March—September 1995[a]

| Sample Attributes | | | Activity (pCi/g) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Record Number[b] | ER Sample ID (Figure 5.4.4-1) | Sample Depth (ft) | Uranium-238 | Thorium-234 | Thorium-232 | Radium-228 | Thorium-228 | Uranium-235 | Cesium-137 | Cobalt-60 |
| **Pre-VCM Samples (No Cleanup Required)** | | | | | | | | | | |
| 03249 | 103E8A-SS | 0–0.5 | ND (4.95) | ND (1.19) | 5.42E-01 | 4.95E-01 | 9.76E-01 | ND (3.56E-01) | ND (5.95E-02) | ND (6.01E-02) |
| 03249 | 103E8B-SS | 0–0.5 | ND (4.47) | ND (9.89E-01) | 3.62E-01 | 4.88E-01 | 4.13E-01 | ND (3.18E-01) | 2.57E-02 | ND (5.04E-02) |
| 03249 | 103E8C-SS | 0–0.5 | 9.24 | 1.04E+01 | 4.27E-01 | 4.51E-01 | ND (1.16) | ND (4.26E-01) | 2.66E-02 | ND (4.90E-02) |
| 03249 | 103E20A-SS | 0–0.5 | 5.70 | 5.49 | 6.35E-01 | 5.48E-01 | 4.01E-01 | ND (3.65E-01) | ND (5.13E-02) | ND (5.22E-02) |
| 03249 | 103E20B-SS | 0–0.5 | ND (4.96) | ND (1.09) | 4.53E-01 | 5.08E-01 | ND (1.04) | ND (3.33E-01) | 2.95E-02 | ND (5.11E-02) |
| 00971 | 103E21-SS | 0–0.5 | ND (6.85) | ND (1.42) | 5.09E-01 | 4.26E-01 | 6.58E-01 | ND (4.71E-01) | ND (6.21E-02) | ND (7.14E-02) |
| **Post-VCM Samples (Cleanup Verification)** | | | | | | | | | | |
| 01351 | 103E1-SS | 0–0.5 | 3.14E+01 | 5.20E+01 | 5.16E-01 | 4.59E-01 | ND (6.12E-01) | 8.83E-01 | ND (2.92E-02) | ND (2.15E-02) |
| 01305 | 103E4A-SS | 0–0.5 | ND (4.51) | ND (1.26) | 2.83E-01 | 3.11E-01 | ND (1.17) | ND (3.47E-01) | 4.71E-02 | ND (5.25E-02) |
| 01305 | 103E5A-SS | 0–0.5 | 1.09E+01 | 9.45 | 3.77E-01 | 4.25E-01 | ND (1.44) | ND (4.36E-01) | ND (5.64E-02) | ND (6.21E-02) |
| 01305 | 103E6A-SS | 0–0.5 | 3.72 | 6.58 | 7.21E-01 | 8.02E-01 | 6.03E-01 | ND (4.83E-01) | 2.24E-02 | ND (6.54E-02) |
| 01305 | 103E7A-SS | 0–0.5 | 8.73 | 9.62 | 3.52E-01 | 2.44E-01 | 4.53E-01 | ND (4.06E-01) | 3.69E-02 | ND (5.56E-02) |
| 01305 | 103E7B-SS (duplicate) | 0–0.5 | 1.29E+01 | 1.91E+01 | 2.65E-01 | 4.01E-01 | ND (1.31) | 3.37E-01 | ND (5.85E-02) | ND (5.17E-02) |
| 01305 | 103E9A-SS | 0–0.5 | 4.50 | 5.83 | 5.52E-01 | 5.02E-01 | ND (1.43) | ND (4.46E-01) | 2.60E-01 | ND (6.47E-02) |
| 01305 | 103E12A-SS | 0–0.5 | 8.66 | 5.61 | 4.30E-01 | 4.51E-01 | ND (1.45) | ND (4.32E-01) | ND (5.80E-02) | ND (6.57E-02) |
| 01305 | 103E13A-SS | 0–0.5 | ND (5.13) | ND (8.08E-01) | 5.07E-01 | 4.00E-01 | 4.23E-01 | ND (3.68E-01) | 2.37E-02 | ND (5.97E-02) |
| 04289 | 103E14A-SS | 0–0.5 | ND (1.73) | 1.22E+00 | 3.71E-01 | 6.07E-01 | ND (1.48) | ND (3.65E-01) | 3.71E-01 | ND (5.39E-02) |
| 00972 | 103E18-SS | 0–0.5 | ND (7.12) | 1.37E+00 | 5.21E-01 | 4.05E-01 | ND (1.67) | ND (4.53E-01) | 2.29E-01 | ND (6.82E-02) |
| 01305 | 103E22A-SS | 0–0.5 | ND (4.84) | 1.70 | 4.23E-01 | 4.30E-01 | 5.53E-01 | ND (3.62E-01) | ND (5.01E-02) | ND (6.17E-02) |
| 01305 | 103E22B-SS (duplicate) | 0–0.5 | 1.82E+01 | 2.21E+01 | 4.95E-01 | 6.12E-01 | ND (1.67) | ND (6.10E-01) | ND (6.74E-02) | ND (4.94E-02) |
| HRMB Maximum Background Surface Soil Concentrations Southwest Area[c] | | | 1.4 | 1.4 | 1.01 | 1.01 | 1.01[d] | 0.16 | 0.664 | NA |

[a]SNL/NM September 1997.
[b]Analysis request/chain of custody record.
[c]Dinwiddie September 24, 1997.
[d]Brown January 14, 1998.

ER = Environmental Restoration.
ft = Feet.
ID = Identification.
NA = Not available.
ND ( ) = Not detected at or above the minimum detectable activity, shown in parenthesis.
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SS = Surface soil sample.
SWMU = Solid waste management unit.
SWTA = Southwest Test Area.
UTL = Upper tolerance limit.
VCM = Voluntary Corrective Measure.

## 5.5 Site Conceptual Model

### 5.5.1 Nature and Extent of Contamination

The COCs at SWMU 103 (metals and radionuclides) are associated with the simulated reactor core materials that were tested at the Large-Scale Melt Facility. PCBs are also considered COCs at SWMU 103 because of a reported release from an electrical transformer. Table 5.5.1-1 summarizes COCs for SWMU 103. The metal COCs that exceed background limits typically occur as isolated *hot spots* of one or two different COCs with no specific COC association or as areas that could be contaminated. Because no background concentrations are applicable to PCBs, any PCB compounds detected can be attributed to soil contamination. Sample analysis results verified the presence of a single PCB compound (Arochlor-1260) at the location of the transformer. However, because Arochlor-1260 was detected below the practical quantitation limit (13 mg/kg) and required an estimation of the actual concentration, any release of PCBs to the soil at SWMU 103 is limited. All levels of PCBs are below any CERCLA, RCRA, or Toxic Substances Control Act (TSCA) cleanup criteria. Radiological COCs associated with DU were detected above background limits at several VCM activity locations.

It is anticipated that no metal or radionuclide COCs exist below the ground surface at any SWMU 103 location because the release mechanism at the site was due to pretest preparation and post-test investigation activities associated with simulated solid-form reactor core materials. Tools and equipment were rinsed in Building 9939C using small amounts of water. Large amounts were used only for reacting residual sodium in the crucibles. These activities were conducted at the crucible spray pits (sodium pits) that comprise SWMU 117.

### 5.5.2 Environmental Fate

Primary sources of COCs for SWMU 103 were simulated reactor core formulations containing metals and DU and an electrical transformer containing PCBs (Figure 5.5.2-1). The primary release mechanism of COCs was to the surface soil. Inadvertent releases of metals and DU occurred during routine material handling activities associated with pre-test preparations and post-test investigations. PCBs were suspected of having been released during the removal of transformers from the north side of Building 9939C. However, analytical results obtained for soil sampling collected in the area indicate no PCB compounds were detected above laboratory practical quantitation limits.

A radiological VCM was conducted during 1995 and 1996 to remove point and area sources exhibiting elevated gamma radiation. To minimize the potential for future contamination of the environment, the test site, personnel, equipment, and to ensure proper methods of cleanup and waste disposal after conducting test activities, site- and experiment-specific Safe Operating Procedures (SOPs) have been developed. Current activities conducted at the site are now performed in accordance with SOP AP473265 (SNL/NM May 1992)

Potential COCs for SWMU 103 are summarized in Table 5.5.1-1. Based on the nature and extent of contamination at the site (Section 5.5.1), metal COCs occur sporadically in the surface soil at concentrations elevated above the maximum background concentrations. Radiological

# Table 5.5.1-1
# Summary of COCs for SWMU 103

| COC Type | Number of Samples | COCs Greater Than Background | Maximum Background Limit/SWTA[a] (mg/kg except where noted) | Maximum Concentration (mg/kg except where noted) | Average Concentration[b] (mg/kg except where noted) | Sampling Locations Where Background Concentration Exceeded |
|---|---|---|---|---|---|---|
| Inorganic Nonradiological | 12 environmental<br>2 duplicates<br>3 off-site splits<br>1 off-site duplicate | Barium | 130 | 220 | 140 | 103-GR-001-0-SS<br>103-GR-002-0-SS<br>103-GR-003-0-SS<br>103-GR-005-0-SS<br>103-GR-007-0-SS<br>103-GR-012-0-SS<br>103-GR-012-0-D<br>103-GR-012-0-SS (split)<br>103-GR-012-0-SS (split) |
| | | Cadmium | <1 | 3.9 | 8 | 103-GR-012-0-SS (split)<br>103-GR-012-0-SS (split) |
| | | Chromium | 17.3 | 220 | 24 | 103-GR-003-0-SS<br>103-GR-004-0-SS<br>103-GR-012-0-SS (split) |
| | | Mercury | <0.25 | ND (0.11) N* | 0.07 | None |
| | | Nickel | 11.5 | 24. | 5.8 | 103-GR-012-0-SS (split) |
| | | Lead | 21.4 | 910 N | 64 | 103-GR-002-0-SS<br>103-GR-003-0-SS<br>103-GR-004-0-SS<br>103-GR-012-0-SS (split) |
| | | Selenium | <1 | ND (50) | 39 | All samples non-detect |
| | | Silver | <1 | ND (10) | 8 | All samples non-detect |
| | | Arochlor-1260 | Not Applicable | 12. J µg/kg | 10.7 µg/kg | 103-GR-012-0-SS |
| Organic | 2 environmental | Arochlor-1016 | Not Applicable | ND (13)[c] | ND (13) | 103-GR-012-0-SS |
| | | Arochlor-1221 | Not Applicable | ND (13) | ND (13) | 103-GR-012-0-SS |
| | | Arochlor-1232 | Not Applicable | ND (13) | ND (13) | 103-GR-012-0-SS |
| | | Arochlor-1242 | Not Applicable | ND (13) | ND (13) | 103-GR-012-0-SS |
| | | Arochlor-1248 | Not Applicable | ND (13) | ND (13) | 103-GR-012-0-SS |
| | | Arochlor-1254 | Not Applicable | ND (13) | ND (13) | 103-GR-012-0-SS |
| Radiological | 17 environmental<br>2 duplicates | U-238 | 1.4 pCi/g | 31.4 | Not Calculated[d] | 103E8C-SS<br>103E20A-SS<br>103E1-SS<br>103E5A-SS<br>103E6A-SS<br>103E7A-SS<br>103E7B-SS<br>103E9A-SS<br>103E12A-SS<br>103E22B-SS |
| | | Th-234 | 1.4 pCi/g | 52.0 pCi/g | Not Calculated | 103E8C-SS<br>103E20A-SS<br>103E1-SS<br>103E5A-SS<br>103E6A-SS<br>103E7A-SS<br>103E7B-SS<br>103E9A-SS<br>103E12A-SS<br>103E22A-SS<br>103E22B-SS |

Refer to footnotes at end of table.

## Table 5.5.1-1 (Concluded)
## Summary of COCs for SWMU 103

| COC Type | Number of Samples | COCs Greater Than Background | Maximum Background Limit/SWTA[a] (mg/kg except where noted) | Maximum Concentration (mg/kg except where noted) | Average Concentration[b] (mg/kg except where noted) | Sampling Locations Where Background Concentration Exceeded |
|---|---|---|---|---|---|---|
| Radiological | 17 environmental<br>2 duplicates | U-235 | 0.16 pCi/g | 0.883 pCi/g | Not Calculated | 103E1-SS<br>103E7B-SS |
| | | U-234 | 0.2 pCi/g | 3.9 pCi/g[e] | Not Calculated | 103E8C-SS<br>103E20A-SS<br>103E1-SS<br>103E5A-SS<br>103E6A-SS<br>103E7A-SS<br>103E7B-SS<br>103E9A-SS<br>103E12A-SS<br>103E22B-SS |
| | | Th-228 | 1.01[c] | 1.05 pCi/g | Not Calculated | 103-GR-010-0-SS |

[a]Dinwiddie September 24, 1997.
[b]Average concentration includes all samples. For nondectectable results, the detection limit is used to calculate the average.
[c]Value in parenthesis represents the practical quantitation given in µg/kg.
[d]Average concentration is not calculated for radionuclides due to the variability in instrument counting error and duration.
[e]U-234 = U-238/8 (Brown January 1998).

COC = Constituents of concern.
J = Estimated value detected at a level less than the practical quantitation limit and greater than or equal to the method detection limit.
mg/kg = Milligram(s) per kilogram.
N = Matrix spike recovery exceeded acceptance limits.
N' = Matrix spike recovery exceeded acceptance limits and the relative percent difference for the duplicate analysis exceeded acceptance limits.
ND () = Not detected at or above the method detection limit or the project reporting limit shown in parenthesis.
pCi/g = Picocurie(s) per gram.
S = Reported value was determined from the method of standard addition.
SWMU= Solid waste management unit.
SWTA = Southwest Test Area.
µg/kg = Microgram(s) per kilogram.

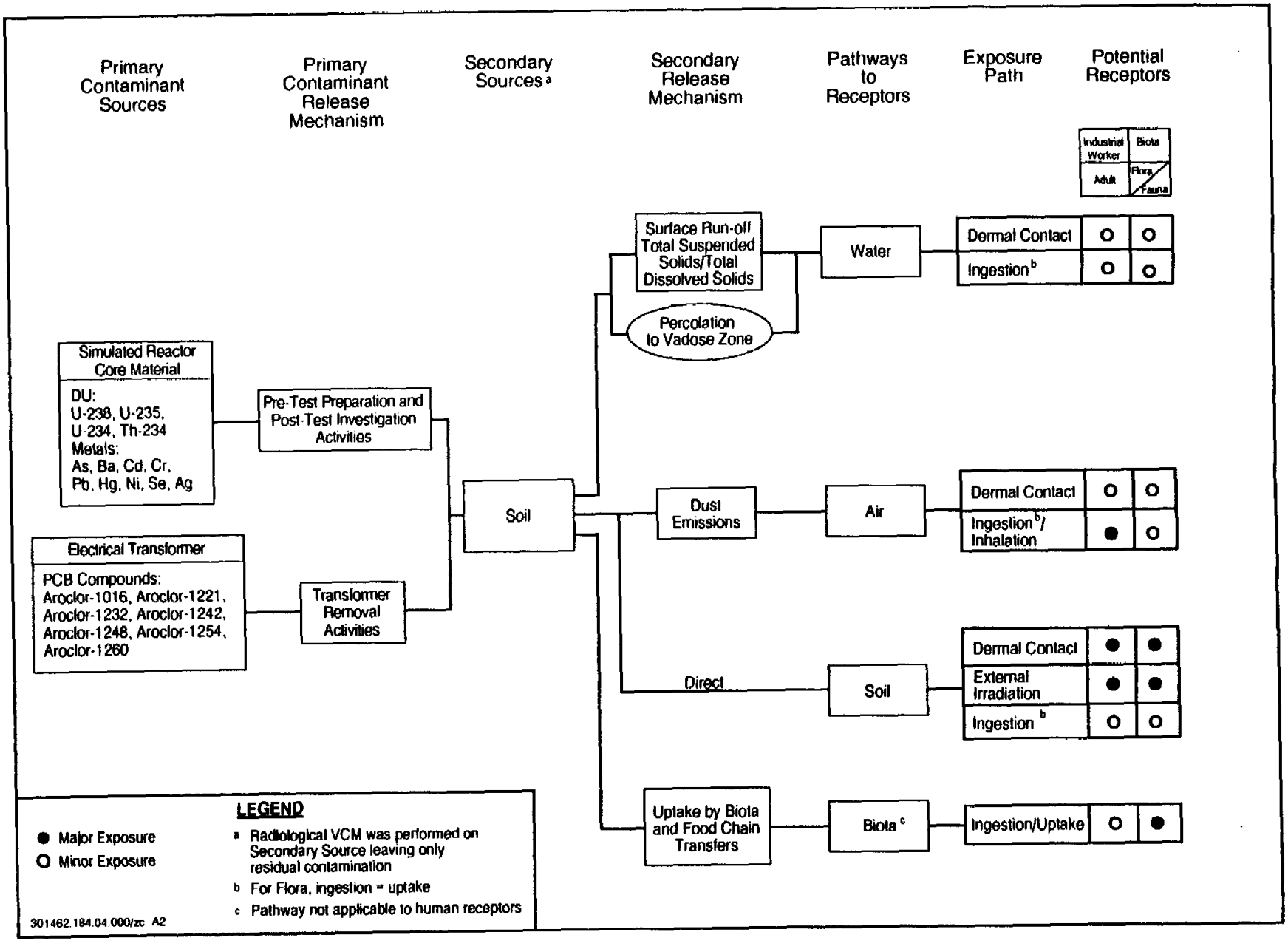



**Figure 5.5.2-1**

**Conceptual Model Flow Diagram for SWMU 103, Scrap Yard (Building 9939)**

COCs occur in the surface soil at concentrations elevated above the maximum background concentrations at several locations where cleanup activities where conducted. No PCB compounds were detected above laboratory practical quantitation limits. The majority of the potential COCs are listed solely because the analytical detection limits exceeded the maximum background limits. With the exception of arsenic, all potential COCs are retained in the conceptual model and evaluated in the human health and ecological risk assessments. Arsenic concentrations exceeding maximum background limits were encountered. Arsenic is not a potential COC from the weathering of scrap metal, nor is there historical documentation from SWMU 103 that identifies any arsenic compounds stored at the site. The presence of isolated occurrences of arsenic is probably related to residual methanearsonic acid in the soil from herbicide use at the scrap yards. Methanearsonic acid is the active ingredient in mono- and disodium salts commonly used in herbicides (Merck and Co., Inc. 1983). Herbicide use at scrap yards was a common practice. Although the herbicides currently in use at SNL/NM do not include products using methanearsonic acid, it is highly probable that methanearsonic acid was used over the past 30 years at the site. In addition, soil sample locations were selected in areas denuded of vegetation increasing the likelihood of collecting soil with residual herbicide. Since arsenic was most likely a constituent resulting from the intended use of an herbicide product it has not been included as a COC.

Since the removal of radiation anomalies at the site, the secondary source of COCs is residual metals and radionuclides in the surface soil. There have been no historical testing activities conducted at SWMU 103 resulting in COCs below the surface soil. Those test activities involving the discharge of potentially contaminated liquids to the soil occurred at the Sodium Pit, which is included in SWMU 117. The secondary release mechanisms at SWMU 103 are therefore limited to the suspension and/or dissolution of COCs in surface water runoff and percolation to the vadose zone, direct contact with soil (radionuclides only), dust emissions, and the uptake of COCs in the soil by biota (Figure 5.5.2-1). Based on depth to groundwater measurements from wells in the site vicinity, depth to groundwater at the site is estimated to occur from 292 to 335 feet feet below ground surface (bgs). The nature and limited extent of COCs at the site, coupled by the depth to groundwater, does not make groundwater a viable pathway for impacts. The pathways to receptors are surface water, soil water, air, and soil (radionuclides). Biota are also a pathway through food-chain transfers. Additional discussion of the fate and transport of COCs at SWMU 103 is provided in Annex 5-B.

The current and future land use for SWMU 103 is industrial (DOE and USAF March 1996). The potential human receptor is the industrial worker. For all applicable pathways, the exposure routes for the industrial worker are dermal contact and ingestion/inhalation. In addition, the industrial worker may be exposed by external irradiation from radionuclides in soil. Only external irradiation and ingestion of soil are considered major exposure routes for the industrial worker. Potential biota receptors include flora and fauna at the site. Similar to the industrial worker, external irradiation and ingestion of soil are considered major exposure routes for biota, in addition to the ingestion of COCs through food-chain transfers or the direct uptake of COCs. A complete discussion of the exposure routes, receptors, and potential risks associated with SWMU 103 is provided in Annex 5-B.

## 5.6 Site Assessments

### 5.6.1 Summary

The site assessment concludes that SWMU 103 does not have significant potential to affect human health under an industrial land-use scenario (Annex 5-B). After consideration of the uncertainties associated with the available data and modeling assumptions, ecological risks associated with SWMU 103 were found to be insignificant (or low). Brief descriptions of the site assessments are provided below and are detailed in Annex 5-B.

### 5.6.2 Risk Screening Assessments

#### *5.6.2.1 Human Health*

SWMU 103 has been recommended for industrial land use (DOE and USAF 1996). A complete discussion of the risk screening assessment process, results, and uncertainties is provided in Annex 5-B. Due to the presence of COCs in concentrations or activities greater than background levels, it was necessary to perform a health risk screening assessment analysis for the site. Besides COC metals, any volatile or semivolatile organic compounds detected above their reporting limits and any radionuclide compounds either detected above background levels and/or MDAs were included in this assessment. The risk screening assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The Risk Screening Assessment calculated the Hazard Index and excess cancer risk for both an industrial and residential land-use setting. The excess cancer risk from nonradiological COCs and the radiological COCs is not additive (EPA 1989).

In summary, the Hazard Index calculated for SWMU 103 nonradiological COCs is 0.05 for an industrial land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental Hazard Index is 0.05. The excess cancer risk for SWMU 103 nonradiological COCs is $5.0 \times 10^{-7}$ for an industrial land-use setting. Guidance from the New Mexico Environment Department (NMED) indicates that excess lifetime risk of developing cancer by an individual must be less than $10^{-6}$ for Class A and B carcinogens and less than $10^{-5}$ for Class C carcinogens (NMED March 1998). The excess cancer risk is driven by chromium, total. Chromium, total is assumed to be chromium VI (most conservative), which is a Class A carcinogen. Thus, the excess cancer risk for this site is below the suggested acceptable risk value ($10^{-6}$). The incremental cancer risk for SWMU 103 is $5.1 \times 10^{-7}$. The incremental total effective dose equivalent for radionuclides for an industrial land-use setting for SWMU 103 is $9.4 \times 10^{-1}$ millirems per year (mrem/yr), which is well below the recommended dose limit of 15 mrem/yr found in EPA's OSWER Directive No. 9200.4-18 (EPA 1997a) and reflected in a document entitled, "Sandia National Laboratories/New Mexico Environmental Restoration Project—RESRAD Input Parameter Assumptions and Justification" (SNL/NM February 1998). The incremental excess cancer risk for radionuclides is $1.0 \times 10^{-5}$ for industrial land-use scenario, which is much less than risk values calculated from naturally occurring radiation and from intakes considered background concentration values.

The residential land-use scenarios for this site are provided only for comparison in the Risk Assessment Report (Annex 5-B). The report concludes that SWMU 103 does not have significant potential to affect human health under an industrial land-use scenario.

#### 5.6.2.2 *Ecological*

As set forth by the NMED Risk-Based Decision Tree, an ecological screening assessment that corresponds with the screening procedures in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997b) was performed. An early step in the evaluation is comparison of COC concentrations and identification of potentially bioaccumulative constituents. This evaluation is presented in Annex 5-B. This methodology also requires the development of a site conceptual model and food web model, and selection of ecological receptors. Each of these items is presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER Program, Sandia National Laboratories/New Mexico" (IT June 1998) and will not be duplicated here. The screen also includes the estimation of exposure and ecological risk.

The results of the ecological risk assessment screen are presented in Table 14, 15, 16, and 17 of Annex 5-B. Site-specific information was incorporated into the screening assessment when such data were available. Hazard Quotients greater than unity were originally predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration (maximum COC concentration was used in the estimation of risk), exposure setting (area use factors of one were assumed), background risk, quality of analytical data, and the use of detection limits as exposure concentrations. Based upon an evaluation of these uncertainties, ecological risks associated with this site are low.

### 5.6.3 Baseline Risk Assessments

#### *5.6.3.1 Human Health*

Based upon the screening assessments summarized in Section 5.6.2.1, a baseline human health risk assessment is not required for SWMU 103.

#### *5.6.3.2 Ecological*

Based upon the screening assessment summarized in Section 5.6.2.2, a baseline ecological risk assessment is not required at SWMU 103.

### 5.6.4 Other Applicable Assessments

#### *5.6.4.1 Underground Storage Tanks*

Closure of a 3,000-gallon underground storage tank (and associated piping) at SWMU 103 was conducted in August 1997 (SNL/NM August 1997). The tank had contained ethylene glycol, which was used as a coolant during testing activities associated with the Large-Scale Melt Facility. Closure activities were performed in conformance with NMED regulations (20 New

Mexico Administrative Code 5), even though ethylene glycol is not a regulated hazardous substance.

#### *5.6.4.2 Other*

No other applicable assessments have been performed at SWMU 103.

## 5.7 No Further Action Proposal

### 5.7.1 Rationale

Based upon field investigation data and the human health risk assessment analysis, an NFA is recommended for SWMU 103 for the following reasons:

- All radiological anomalies detected at SWMU 103 were confirmed remediated following the VCM removal activities.
- No nonradiological or radiological COCs were present in soil at concentrations or activity levels considered hazardous to human health for an industrial land-use scenario.
- Risk assessment for ecological receptors indicates that the ecological risks associated with SWMU 103 are insignificant.

### 5.7.2 Criterion

Based upon the evidence provided above, SWMU 103 is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states that the SWMU has been fully characterized and remediated in accordance with current and applicable state or federal regulations and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use.

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# ANNEX 5-B
# SWMU 103 Risk Screening Assessment Report

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## LIST OF TABLES

# SWMU 103: RISK SCREENING ASSESSMENT

## I. Site Description and History

Sandia National Laboratories/New Mexico (SNL/NM) Solid Waste Management Unit (SWMU) 103 is located west of Lovelace Road about 2 miles south of Coyote Springs Road and 1.6 miles north of the Solar Power Tower. The scrap yard at Building 9939 is associated with the Large-Scale Melt Facility, an active site used to test nuclear reactor meltdown scenarios. The size of the site is approximately 6 acres. The site is located on U.S. Air Force land permitted to the U.S. Department of Energy (DOE) and SNL/NM. The terrain is generally flat with a gentle slope to the west and a shallow arroyo several hundred feet to the north that goes to an internal drainage basin. Vegetation is primarily grasses and tumbleweeds.

SWMU 103 lies on the eastern margin of the Sandia-Tijeras fault complex at a mean elevation of 5,612 feet above sea level. The 1994 Site-Wide Hydrogeologic Characterization Project (SWHCP) Annual Report (SNL/NM March 1995) presents general soil characteristics for the area around SWMU 103. The dominant surface soil group in the area is Wink fine sandy loam. The soil infiltration rate is estimated to be on the order of 0.1 centimeter per year (cm/yr), which yields a downward seepage velocity ranging between 0.03 and 11.8 cm/yr (SNL/NM March 1995).

SWMU 103 is located in the HR-2 hydrological region described in the 1994 SWHCP Annual Report (SNL/NM March 1995). This region is a transitional geohydrologic zone between the HR-1 zone to the west and HR-3 to the east. It is comprised of a northeastern/southwestern-trending fault complex that includes segments of the Sandia, Tijeras, and Hubbell Springs Faults. It has been determined that the uppermost interval of groundwater saturation in the HR-2 zone is unconfined-to-semiconfined aquifers in the alluvial facies of the Santa Fe Group and piedmont alluvium, and semiconfined-to-confined aquifers in the local bedrock units. These faults not only complicate the local hydrostratigraphy, but are likely to have a significant impact on groundwater flow. The estimated hydraulic conductivity of the local aquifers is highly variable from approximately 0.004 to 0.10 foot per minute in the shallow alluvium; 0.00001 to 0.0005 foot per minute in the Santa Fe Group alluvial fan facies; and 0.000002 to 0.007 foot per minute in bedrock units (SNL/NM March 1995).

The nearest groundwater monitoring well, LMF-1, is located approximately 1,400 feet from SWMU 103 at the Large-Scale Melt Facility. The depth to groundwater at LMF-1 varied between 335 feet in January 1996 and 292 feet in December 1996 (SNL/NM March 1997). The uppermost interval of groundwater saturation underlying SWMU 103 is the Abo Sandstone aquifer unit. Local groundwater flow is predominantly to the west, although nearby fault boundaries may significantly alter the flow direction (SNL/NM March 1996). The nearest production well, KAFB-4, is located approximately 5 miles to the northwest of the site. No perennial surface-water bodies are present in the vicinity of SWMU 103.

For a detailed discussion regarding the local setting at SWMU 103, refer to the "RCRA [Resource Conservation and Recovery Act] Facility Investigation Work Plan for OU [Operable Unit] 1335, Southwest Test Area" (SNL/NM March 1996).

## II. Comparison of Results to Data Quality Objectives

The scoping and voluntary corrective measure (VCM) verification cleanup sampling programs conducted at SWMU 103 were designed to collect adequate samples to:

- Determine whether hazardous waste or hazardous constituents have been released at the site
- Characterize the nature and extent of any releases
- Verify the cleanup of radiation anomalies
- Provide sufficient Level 3 analytical data to support risk screening assessments.

Table 1 summarizes the sample location design for SWMU 103. The source of potential constituents of concern (COC) at SWMU 103 are metals and depleted uranium (DU) used in reactor safety experiments conducted at the Large-scale Melt Facility. Material handling practices used during test preparation and post-test investigation activities resulted in the inadvertent contamination of surface soils.

**Table 1**
**Summary of Sampling Performed to Meet Data Quality Objectives**

| SWMU Subunit | Potential COC Source | Number of Sampling Locations | Sample Density | Sampling Location Rationale |
|---|---|---|---|---|
| Scoping | Metals and DU in surface soil, PCBs potentially released from transformer | 12 | Judgmental based upon locations of test activities performed at the site where COCs are most likely to be present | Sample locations distributed near Building 9939A (location of test chamber); Building 9939C (location of DU crushing and loading operations); Building 9939E (a radioactive material storage building); a concrete pad near the sodium disposal pits; and where a PCB release reportedly occurred during removal of electrical transformers |
| Pre-VCM | DU in surface soil | 8 | Judgmental based upon size of area source anomalies and location(s) of highest gamma measurements | Sample locations based upon point and area radiation source anomalies to determine if remediation was required |
| Post-VCM | Residual DU in surface soil | 11 | Judgmental for remediated radiation area source anomalies based upon size of area source and location(s) of highest residual gamma measurements; 10 percent of all remediated radiation point source anomalies | Sample locations in the immediate vicinity of remediated point source anomalies and the location(s) of highest residual gamma readings for remediated area source anomalies. |

COC = Constituent of concern.
DU = Depleted uranium.
PCB = Polychlorinated biphenyls.
SWMU = Solid waste management unit.
VCM = Voluntary corrective measure.

The number and location of the samples collected in the scoping sampling program depended upon the completeness of the historical information for activities conducted at the site. In general, scoping samples were collected from areas where potential COCs were most likely to be detected and simulated reactor core materials were known to have been managed during test preparation and post-test investigation activities. In addition, scoping samples were collected from an area where polychlorinated biphenyls (PCB) were suspected of having been released during the removal of electrical transformers near Building 9939C.

The number and location of the samples collected in the pre- and post-VCM sampling programs was dependent on the Phase I Gamma Survey conducted at the site and the cleanup activities performed at the site. Precleanup samples were collected from specific point and area source anomalies to determine whether remediation at these locations would be required. Postcleanup samples were collected from point and area source anomalies to verify that remediation goals were achieved.

Table 2 summarizes the analytical methods and data quality requirements necessary to (1) adequately characterize hazardous waste or hazardous constituents, including PCBs, and residual DU remaining after remediation activities and (2) support risk screening assessments.

**Table 2**
**Summary of Data Quality Requirements**

| Analytical Requirement | Data Quality Level | ER Chemistry Laboratory Department 6133 SNL/NM | Radiation Protection Sample Diagnostics Laboratory Department 7713 SNL/NM | Lockheed Analytical Services Las Vegas, Nevada |
|---|---|---|---|---|
| TAL metals<br>EPA Method 6010/7000 | Level 3 | 12 samples<br><br>2 (internal duplicates) | Not applicable | 3 samples (off-site duplicates)<br><br>1 sample (off-site internal duplicates) |
| PCBs<br>EPA Method 8080 | Level 3 | Not applicable | Not applicable | 2 samples |
| Gamma Spectroscopy | Level 2 | Not applicable | 12 samples (scoping)<br>17 samples (pre- and post-VCM)<br><br>2 (internal duplicates for scoping)<br>2 (internal duplicates for post-VCM) | Not applicable |

EPA = U.S. Environmental Protection Agency
ER = Environmental Restoration.
PCB = Polychlorinated biphenyls.
SNL/NM = Sandia National Laboratories/New Mexico.
TAL = Target analyte list.
VCM = Voluntary corrective measure

SNL/NM on-site laboratories analyzed samples from 12 locations at SWMU 103 for target analyte list (TAL) metals. Twenty percent of the samples were sent off site for verification analyses for TAL metals. In addition, two of the samples were also analyzed off site for PCBs. The minimum detection limits (MDL) for all on-site analyses exceeded the background concentration limits for arsenic, cadmium, selenium, and silver. The off-site laboratory provided a lower MDL for metals analyses of split samples. The cadmium MDL is 1.0 milligrams per kilogram (mg/kg) as compared to the background concentration limit of less than 1.0 mg/kg. The selenium MDL ranges from 1.0 to 1.1 mg/kg as compared to the background concentration limit of less than 1.0 mg/kg. The silver MDL ranges from 2.0 to 2.1 mg/kg as compared to a background concentration limit of less than 1.0 mg/kg. In general, the lower MDLs for the off-site split samples compared to the background concentration limits.

All gamma spectroscopy results were reviewed by SNL/NM Department 7713 in accordance with the Radiation Protection Sample Diagnostics Procedure RPSD-02-11 (SNL/NM July 1996). The SNL/NM Sample Management Office conducted Data Validation I and II reviews on all off-site laboratory results in accordance with Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994). The reviews performed by SNL/NM confirmed that the data are acceptable for use in the no further action (NFA) proposal for SWMU 103. The data quality objectives (DQO) for SWMU 103 have been met.

## III. Determination of Nature, Rate, and Extent of Contamination

### III.1 Introduction

The determination of the nature, rate, and extent of contamination at SWMU 103 was based upon an initial conceptual model validated by scoping and VCM sampling programs conducted at the site. The initial conceptual model was developed from historical background information including site inspections, personal interviews, historical photographs, and radiological surveys. The scoping sample data used to characterize SWMU 103 were collected in accordance with the rationale and procedures described in the site-specific sampling and analysis plan (SNL/NM July 1995). The VCM sampling data used to characterize SWMU 103 were collected in accordance with the rationale and procedures described in the final report documenting VCM activities (SNL/NM September 1997). The data collected were subsequently used to develop the final conceptual model for SWMU 103, which is presented in Section 5.5 of the associated NFA proposal. The quality of the data specifically used to determine the nature, rate, and extent of contamination are described below.

### III.2 Nature of Contamination

The nature of contamination at SWMU 103 was determined with analytical testing of soil media and the potential for degradation of relevant COCs (Section V). The analytical requirements included TAL metals to determine whether any release of such constituents occurred at the site. Gamma spectroscopy was used to assess residual DU concentrations remaining at the site after completion of remediation activities. PCB analyses were performed on selected soil samples from SWMU 103 to characterize a suspected release from transformers located on the site. These analytes and methods are appropriate to characterize the COCs and potential degradation products associated with historical activities at SWMU 103.

### III.3 Rate of Contaminant Migration

All primary sources of COCs in soil were removed as part of a radiological VCM performed between March of 1995 and June of 1996. Secondary sources of COCs are residual metals and DU still remaining in the soil. The rate of COC migration predominantly depends upon site meteorological and surface hydrologic processes as described in Section V. Data available from the SWHCP (published annually); numerous SNL/NM air, surface-water, and radiological monitoring programs; biological surveys; and other governmental atmospheric monitoring at the Kirtland Air Force Base (KAFB) (i.e., National Oceanographic and Atmospheric Administration) are adequate to characterize the rate of COC migration at SWMU 103.

### III.4 Extent of Contamination

Scoping soil samples were collected from the locations where simulated reactor core material handling was performed during test preparation and post-test investigation activities conducted at the Large-Scale Melt Facility. Pre- and post-VCM samples collected were based upon the Phase I Gamma Survey conducted at the site and the VCM activities performed at the site. Pre-VCM samples were collected from specific point and area source anomalies to determine if remediation at these locations would be required. Post-VCM samples were collected from point and area source anomalies to verify remediation goals were achieved. These sample locations are deemed appropriate to determine the lateral extent of COC migration.

The sample density for the scoping sampling program was judgmental based upon the extent and location of simulated reactor core material handling activities performed at the site. The sample density for the VCM sampling programs was judgmental for radiation area source anomalies based upon size of area source and location(s) of highest residual gamma measurements. Ten percent of all remediated radiation point source anomalies were sampled. The sample number was deemed sufficient to establish the presence of detectable DU residues remaining after remediation activities were completed at SWMU 103.

Material handling procedures resulted in the inadvertent contamination of surface soil at SWMU 103 with solid particles ranging in size from fine particulates to larger fragments. Because of the relatively low solubility of most metals, limited precipitation, and high evapotranspiration, the vertical rate of contamination migration is expected to be extremely low. Therefore, samples were collected from the ground surface to a depth of 6 inches below ground surface (bgs). There is no historical information that any subsurface disturbance, testing, or disposal ever occurred at the site that might have mixed surface soils beneath the 6-inch depth. Therefore, the 6-inch surface sample depth represents the media potentially impacted by site activities and is sufficient to determine the vertical extent of COC migration.

In summary, the design of the scoping and cleanup sampling programs was appropriate and adequate to determine the nature, rate, and extent of contamination.

## IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the SWMU 103 NFA proposal. Generally, COCs evaluated in this risk assessment include all detected organics and relevant radioactive contaminants and all inorganic COCs analyzed. If the detection limit of an organic compound was too high (could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetect organics not included in this assessment were determined to have sufficiently low detection limits to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. The approved SNL/NM maximum background concentration (Dinwiddie September 24, 1997) was selected to provide a background screen in Tables 3 and 4. Human health nonradiological COCs were also compared to proposed Subpart S action levels calculated for SNL/NM (Table 3) (IT July 1994).

Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium are not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs are evaluated. The nonradiological COCs evaluated in this risk assessment include polychlorinated biphenyls (PCBs) and inorganics.

Nonradiological COCs for human health and ecological risk assessment at SWMU 103 are listed in Table 3. Radiological COCs are listed in Table 4. Both tables show the associated approved SNL/NM maximum background concentration values (Dinwiddie September 24, 1997). Discussion of Tables 3 and 4 are provided in Section VI.4 and Sections VII.2 and VII.3, respectively.

## V. Fate and Transport

The primary release of COCs at SWMU 103 was to the surface soil. Wind, water, and biota are natural mechanisms of COC transport from the primary release point. Excavation and removal of soil are potential human-caused mechanisms of transport. Winds can be strong in the open grassland environment at SWMU 103. Moderate winds can transport soil particles with adsorbed COCs (or COCs in particulate form) as suspended dust, capable of dry or wet deposition. Strong winds may move larger (sand-sized) particles by saltation. Wind erosion is reduced if the soil surface is moist or if it is protected by vegetation or other cover.

Water at SWMU 103 is received as precipitation (rain or occasionally snow). The average annual precipitation in this area is about 8 inches (NOAA 1990) and the evapotranspiration value is 95 percent of the total rainfall (Thomson and Smith 1985). Precipitation will either infiltrate or form runoff. Infiltration at the site is enhanced by the nearly flat (level) relief and the sandy nature of the soil (the soil in the area of the site is primarily Madurez fine sandy loam and Wink fine sandy loam [USDA 1977]). Runoff from the site is probably significant only during intense rainfall events and during extended rainfall periods when soils are near saturation. Surface runoff in the area of SWMU 103 is to the west toward an internal drainage basin, but no major surface drainage features occur on the site. Runoff may contain soil particles with

## Table 3
## Nonradiological COCs for Human Health and Ecological Risk Assessment at SWMU 103 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log $K_{ow}$

| COC Name | Maximum Concentration (mg/kg) | SNL/NM Background Concentration (mg/kg)[a] | Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value? | BCF (maximum aquatic) | Log $K_{ow}$ (for organic COCs) | Bioaccumulator?[b] (BCF>40, log $K_{ow}$>4) | Subpart S Screening Value[c] | Is Individual COC less than 1/10 of the Action Level? |
|---|---|---|---|---|---|---|---|---|
| Barium | 220 | 130 | **No** | 170[d] | NA | **Yes** | 6,000 | Yes |
| Beryllium | 0.5[f] | 0.65 | Yes | 19[e] | NA | No | 0.2 | **No** |
| Cadmium | 5[f] | <1 | **No** | 64[e] | NA | **Yes** | 80 | Yes |
| Chromium, total[g] | 220 | 17.3 | **No** | 16[e] | NA | No | 400 | **No** |
| Lead | 910 N | 21.4 | **No** | 49[e] | NA | **Yes** | -- | -- |
| Mercury | 0.06[f] N* | <0.25 | **Unknown** | 5,500[e] | NA | **Yes** | 20 | Yes |
| Nickel | 24 | 11.5 | **No** | 47[e] | NA | **Yes** | 2,000 | Yes |
| Selenium | 25[f] | <1 | **No** | 800[h] | NA | **Yes** | 400 | Yes |
| Silver | 5[f] | <1 | **No** | 0.5[f] | NA | No | 400 | Yes |
| Arochlor-1260 | 0.012 J | NA | **NA** | 31,200[e] | 6.72[d] | **Yes** | 25 | Yes |

[a]From Dinwiddie (September 24, 1997) Southwest Test Area.
[b]NMED (March 1998)
[c]IT (July 1994).
[d]BCF from Neumann (1976).
[e]BCF and/or Log $K_{ow}$ from Yanicak (March 1997).
[f]COC not detected, concentration assumed to be one-half of the detection limit.
[g]Assumed to be chromium VI for Subpart S Screening Level (most conservative).
[h]BCF from Callahan et al. (1979).

BCF = Bioconcentration factor.
COC = Constituents of concern.
J = Estimated concentration.
$K_{ow}$ = Octanol-water partition coefficient.
Log = Logarithm (base 10).
mg/kg = Milligram(s) per kilogram.
N = Matrix spike recovery exceeded acceptance limits.
N* = Matrix spike recovery exceeded acceptance limits and the relative percent difference for the duplicate analysis exceeded acceptance limits.
NA = Not applicable.
NMED = New Mexico Environment Department.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid waste management unit.
-- = Information not available.

## Table 4
## Radiological COCs for Human Health and Ecological Risk Assessment at SWMU 103 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log $K_{ow}$

| COC Name | Maximum Concentration (pCi/g) | SNL/NM Background Concentration (pCi/g)[a] | Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value? | BCF (maximum aquatic) | Bioaccumulator?[c] (BCF>40, log $K_{ow}$>4) |
|---|---|---|---|---|---|
| U-238 | 31.4 | 1.4 | No | 900[d] | Yes |
| U-235 | 0.88 | 0.16 | No | 900[d] | Yes |
| U-234 | 3.92 | 1.4 | No | 900[d] | Yes |
| Th-232 | 0.72 | 1.01 | Yes | -- | No[f] |
| Th-234 | 52.0 | 1.4 | No | -- | No[f] |
| Ra-228 | 0.80 | 1.01 | Yes | 30,000[d] | No[f] |
| Cs-137 | 0.37 | 0.664 | Yes | 3000[e] | Yes |

[a]From Dinwiddie (September 24, 1997), Southwest Test Area.
[b]U-234 values were calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio was equal to that detected during waste characterization of DU-contaminated soils generated during the radiological voluntary corrective measures project, where U-234=U-238/8 (Brown January 1998).
[c]NMED (March 1998).
[d]Baker and Soldat (1992).
[e]BCF from Yanicak (March 1997).
[f]Not considered a bioaccumulator (Yanicak March 1997).
BCF = Bioconcentration factor.
COC = Constituents of concern.
DU = Depleted uranium.
Log = Logarithm (base 10).
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid waste management unit.
-- = Information not available.

adsorbed COCs. The distance of transport will depend upon the size of the particle and the velocity of the water (generally low because of the flat terrain).

Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached. COCs desorbed from the soil particles into the soil solution may be leached into the subsurface soil with this percolation. The effective rooting depths of the soil at SWMU 103 is about 60 inches (USDA 1977), indicating the depth of the system's transient water cycling zone defined by the dynamic balance between percolation/infiltration and evapotranspiration. Because groundwater at this site is approximately 292 to 335 feet bgs, the potential for COCs to reach groundwater through the unsaturated zone above the water table is very low. As water from the surface evaporates, the direction of COC movement may be reversed with capillary rise of soil water. Vegetation increases the rate of water loss from the soil through transpiration.

Plant roots can take up COCs that are in the soil solution. This may be a passive process, but active uptake (i.e., requiring energy expenditure on the part of the plant) or exclusion of some constituents in the soil solution may also take place. COCs taken up by the roots may be transported to the aboveground tissues with the xylem stream. Aboveground tissues can take up adsorbed constituents directly from the air or by contact with dust particles. Organic constituents in plant tissues may be metabolized or released through volatilization. That which remains in the tissue may be consumed by herbivores or eventually returned to the soil as litter. Aboveground litter is capable of transport by wind until consumed by decomposer organisms in the soil. Constituents in plant tissues that are consumed by herbivores may pass through the gut and be returned to the soil in feces (at the site or transported from the site in the herbivore), or may be absorbed to be held in tissues, metabolized, or excreted. The herbivore may be eaten by a primary carnivore or scavenger and the constituent still held in the consumed tissues will repeat the sequence of absorption, metabolization, excretion, and consumption by higher predators, scavengers, and decomposers. The potential for transport of the constituents depends upon the mobility of the species that comprise the food chain and the potential for the constituent to be transferred across the links in the food chain.

Degradation of COCs at SWMU 103 may result from biotic or abiotic processes. Most COCs at SWMU 103 are inorganic and elemental in form, and are, therefore, not considered to be degradable. Radiological COCs, however, undergo decay to stable isotopes or radioactive daughter elements. Other transformations of inorganics may include changes in valence (oxidation/reduction reactions) or incorporation into organic forms (e.g., the conversion of selenite or selenate from soil to seleno-amino acids in plants). Degradation processes for organic COCs may include photolysis, hydrolysis, and biotransformation. Photolysis requires light, and therefore takes place in the air, at the ground surface, or in surface water. Hydrolysis includes chemical transformations in water, and may occur in the soil solution. Biotransformation is the metabolization of COCs in biota, including microorganisms, plants, and animals.

Table 5 summarizes the fate and transport processes that may occur at SWMU 103. COCs at this site are primarily inorganics (metals and DU) in surface soil. Because this site is disturbed, vegetative cover is low. Therefore, the potential for transport of COCs by wind is possible and the potential for uptake into the food chain is low. Transport by surface-water runoff is moderated by the low slope and high infiltration of the soil. Significant leaching into the subsoil is unlikely for most inorganics, and leaching to the groundwater is highly unlikely. Degradation

**Table 5**
**Summary of Fate and Transport at SWMU 103**

| Transport and Fate Mechanism | Viable Mechanism | Significance |
|---|---|---|
| Wind | Yes | Moderate to high |
| Surface runoff | Yes | Moderate to low |
| Migration to groundwater | No | None |
| Food chain uptake | Yes | Low (inorganics)<br>Moderate to high (PCBs) |
| Transformation/degradation | Yes | Low |

of the inorganic COCs is insignificant, and methylation of selenium is unlikely because of low biological activity. Arochlor-1260 (a PCB) is the only organic COC detected at this site. The loss of PCBs by wind, water, or degradation is expected to be low; however, uptake and bioconcentration by biota may be high if contact occurs, and biomagnification in the food chain can occur for these compounds. The potential for food chain uptake at this site is moderated by the degree of disturbance and the consequent lack of significant contact with ecological receptors.

## VI. Human Health Risk Screening Assessment

### VI.1 Introduction

Human health risk screening assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include:

| | |
|---|---|
| Step 1. | Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site. |
| Step 2. | Potential pathways are identified by which a representative population might be exposed to the COCs. |
| Step 3. | The potential intake of these COCs by the representative population is calculated using a tiered approach. The first component of the tiered approach includes two screening procedures. One screening procedure compares the maximum concentration of the COC to an approved SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are subjected to a second screening procedure that compares the maximum concentration of the COC to the SNL/NM proposed Subpart S action level. |
| Step 4. | Toxicological parameters are identified and referenced for COCs that were not eliminated during the screening steps. |
| Step 5. | Potential toxicity effects (specified as a Hazard Index [HI]) and excess cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide. |
| Step 6. | These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA) and DOE to determine whether further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated. |
| Step 7. | Uncertainties in the previous steps are discussed. |

## VI.2 Step 1. Site Data

The description and history for SWMU 103 is provided in Section I. Comparison of results to DQOs is presented in Section II. The determination of the nature, rate and extent of contamination is described in Section III.

## VI.3 Step 2. Pathway Identification

SWMU 103 has been designated with a future land-use scenario of industrial (DOE and USAF March 1996) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is included because of the potential to inhale dust and volatiles. Soil ingestion is also included for the radiological COCs. No contamination at depth was identified, and therefore no water pathways to the groundwater are considered. Depth to groundwater at SWMU 103 is approximately 292 to 335 feet bgs. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered not to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

**Pathway Identification**

| Nonradiological Constituents | Radiological Constituents |
|---|---|
| Soil ingestion | Soil ingestion |
| Inhalation (dust and volatiles) | Inhalation (dust) |
| Plant uptake (residential only) | Plant uptake (residential only) |
| | Direct gamma |

## VI.4 Step 3. COC Screening Procedures

Step 3 is discussed in this section and includes two screening procedures. The first screening procedure is a comparison of the maximum COC concentration to the approved SNL/NM background concentration levels. The second screening procedure compares maximum COC concentrations to the proposed Subpart S action levels calculated for SNL/NM. This second procedure is applied only to COCs that are not eliminated during the first screening procedure.

### VI.4.1 Background Screening Procedure

#### *VI.4.1.1 Methodology*

Maximum concentrations of COCs are compared to the approved SNL/NM maximum screening level for this area (Dinwiddie September 24, 1997). The approved SNL/NM maximum background concentrations are selected to provide the background screen for nonradiological

COCs in Table 3 and used to calculate risk attributable to background in Table 9. Only the COCs that are above their respective SNL/NM maximum background screening levels or do not have a quantifiable background screening level are considered in further risk assessment analyses.

For radiological COCs that exceed the SNL/NM background screening levels, background values are subtracted from the individual maximum radionuclide concentrations. Those that do not exceed these background levels are not carried any further in the risk assessment. This approach is consistent with DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1993). Radiological COCs that do not have a background value and are detected above the analytical minimum detectable activity are carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

#### *VI.4.1.2 Results*

A comparison of SWMU 103 maximum COC concentrations to the approved SNL/NM maximum background values (Dinwiddie September 24, 1997) for human health risk assessment is presented in Tables 3 and 4. For the nonradiological COCs, four constituents have maximum measured values greater than their respective background screening levels. Three constituents were nondetect but their corresponding default concentrations (0.5 of the detection limit) are greater than their respective background screening levels. One nonradiological COC that was nondetect has no quantifiable background concentration, so it is not known whether that COC exceeded background. One COC is an organic compound and does not have a background screening level.

The maximum concentration value for lead is 910 N mg/kg. The EPA intentionally provides no human health toxicological data on lead, and therefore, no risk parameter values can be calculated. However, EPA Region 6 guidance for the screening value for lead for an industrial land-use scenario is 2,000 mg/kg (EPA 1996a). The maximum concentration value for lead at this site is less than this screening value, and therefore lead is eliminated from further consideration in the human health risk assessment.

For the radiological COCs, four constituents had maximum activities greater than their respective background (U-238, U-235, U-234, and Th-234). All are constituents of DU. No other radionuclides were detected above background levels.

### VI.4.2 Subpart S Screening Procedure

#### *VI.4.2.1 Methodology*

The maximum concentrations of nonradiological COCs not eliminated during the background screening process were compared with action levels (IT July 1994) calculated using methods and equations promulgated in the proposed RCRA Subpart S (EPA 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989). Accordingly, all calculations were based upon the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface, this assumption is considered valid. If there are ten or fewer

COCs and each has a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there are more than ten COCs, the Subpart S screening procedure is not performed.

#### *VI.4.2.2 Results*

Table 3 shows the COCs and the associated proposed Subpart S action level. The table compares the maximum concentration values to 1/10 of the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the EPA (EPA 1996b). One or more COCs do not have a concentration less than 1/10 of the proposed Subpart S action level. Therefore, the site fails the Subpart S screening criteria and a hazard quotient (HQ) and excess cancer risk value must be calculated for all the COCs.

Radiological COCs have no predetermined action levels analogous to proposed Subpart S levels, and therefore this step in the screening process is not performed for radiological COCs.

### VI.5 Step 4. Identification of Toxicological Parameters

Tables 6 (nonradiological) and 7 (radiological) show the COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used for nonradiological COCs in Table 6 are from the Integrated Risk Information System (IRIS) (EPA 1998), Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), EPA Region 9 (EPA 1996c) and EPA Region 3 (EPA 1997b) databases. Dose conversion factors (DCF) used in determining the excess TEDE values for radiological COCs for the individual pathways were the default values provided in the RESRAD computer code (Yu et al. 1993a) as developed in the following documents:

- A DCF for ingestion and inhalation is taken from "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion" (EPA 1988).

- DCFs for surface contamination (contamination on the surface of the site) were taken from DOE/EH-0070, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public" (DOE 1988).

- DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil" (Kocher 1983) and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu et al. 1993b).

**Table 6**
**Toxicological Parameter Values for SWMU 103 Nonradiological COCs**

| COC Name | $RfD_o$ (mg/kg-d) | Confidence[a] | $RfD_{inh}$ (mg/kg-d) | Confidence[a] | $SF_o$ $(mg/kg\text{-}day)^{-1}$ | $SF_{inh}$ $(mg/kg\text{-}day)^{-1}$ | Cancer Class[b] |
|---|---|---|---|---|---|---|---|
| Barium | 7E-2[c] | M | 1.4E-4[d] | -- | -- | -- | -- |
| Cadmium | 5E-4[c] | H | 5.7E-5[d] | -- | -- | 6.3E+0[c] | B1 |
| Chromium III | 1E+0[c] | L | 5.7E-7[e] | -- | -- | -- | -- |
| Chromium VI | 5E-3[c] | L | -- | -- | -- | 4.2E+1[c] | A |
| Mercury | 3E-4[f] | -- | 8.6E-5[c] | M | -- | -- | D |
| Nickel | 2E-2[c] | M | -- | -- | -- | -- | -- |
| Selenium | 5E-3[c] | H | -- | -- | -- | -- | D |
| Silver | 5E-3[c] | L | -- | -- | -- | -- | D |
| Arochlor-1260 | -- | -- | -- | -- | -- | -- | -- |
| PCBs, total | -- | -- | -- | -- | 2E+0[c] | 4E-1[c] | B2 |

[a]Confidence associated with IRIS (EPA 1998) database values (L = low, M = medium, H = high).
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998):

A - Human carcinogen
B1 - Probable human carcinogen. Limited human data are available
B2 - Probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
D - Not classifiable as to human carcinogenicity.

[c]Toxicological parameter values from IRIS electronic database (EPA 1998).
[d]Toxicological parameter values from EPA Region 9 electronic database (EPA 1996c).
[e]Toxicological parameter values from EPA Region 3 electronic database (EPA 1997b).
[f]Toxicological parameter values from HEAST database (EPA 1997a).

COC = Constituent of concern.
mg/kg-day = Milligram(s) per kilogram day.
$(mg/kg\text{-}day)^{-1}$ = Per milligram per kilogram day.
$RfD_o$ = Oral chronic reference dose.
$RfD_{inh}$ = Inhalation chronic reference dose.
$SF_o$ = Oral slope factor.
$SF_{inh}$ = Inhalation slope factor.
SWMU = Solid waste management unit.
-- = Information not available.

**Table 7**
**Radiological Toxicological Parameter Values for SWMU 103 COCs Obtained from RESRAD Risk Coefficients[a]**

| COC Name | $SF_o$ (1/pCi) | $Sf_{inh}$ (1/pCi) | $Sf_{ev}$ (g/pCi-yr) | Cancer Class[b] |
|---|---|---|---|---|
| U-238 | 6.20E-11 | 1.20E-08 | 6.60E-08 | A |
| U-234 | 4.40E-11 | 1.40E-08 | 2.10E-11 | A |
| U-235 | 4.70E-11 | 1.30E-08 | 2.70E-07 | A |

[a]From Yu et al. (1993a).
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A - human carcinogen.
[c]U-238 also accounts for Th-234 contribution, since Th-234 is short-lived U-238 progeny.
COC = Constituent of concern.
$SF_o$ = Oral (ingestion) slope factor.
$SF_{inh}$ = Inhalation slope factor.
$SF_{ev}$ = External volume exposure slope factor.
SWMU = Solid waste management unit.
1/pCi = One per picocurie.
g/pCi-yr = Gram(s) per picocurie-year.

## VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI value and the excess cancer risk, for both the potential nonradiological COCs and associated background for industrial and residential land uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for both industrial and residential land uses.

### VI.6.1 Exposure Assessment

Appendix 1 of this report shows the equations and parameter input values used in calculating intake values and subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both industrial and residential land-use scenarios. The equations for nonradiological COCs are based upon RAGS (EPA 1989). The parameters are based upon information from the RAGS (EPA 1989) as well as other EPA guidance documents and reflect the reasonable maximum exposure (RME) approach advocated by RAGS (EPA 1989). For radiological COCs, the coded equations provided in the RESRAD computer code are used to estimate the incremental TEDE and cancer risk for the individual exposure pathways. Further discussion of this process is provided in the Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu et al. 1993a).

Although the designated land-use scenario is industrial for this site, risk and TEDE values for a residential land-use scenario are also presented. These residential risk and TEDE values are presented only to provide perspective of potential for risk to human health under the more restrictive land-use scenario.

VI.6.2 Risk Characterization

Table 8 shows an HI value of 0.05 for the SWMU 103 nonradiological COCs and an excess cancer risk of $5 \times 10^{-7}$ for the designated industrial land-use scenario. The numbers presented include exposure from soil ingestion and dust and volatile inhalation for the nonradiological COCs. Table 9 shows the HI is 0.00, assuming the maximum background concentrations of the SWMU 103 associated background constituents, and there is no quantifiable excess cancer risk for the designated industrial land-use scenario.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the industrial land-use scenario, the most limiting case TEDE was calculated for an individual who spends time equally indoors and outdoors at the site. This resulted in an incremental TEDE of $9.4 \times 10^{-1}$ millirem per year (mrem/yr). In accordance with EPA guidance, an incremental TEDE of 15 mrem/yr (EPA 1997c) is used for the probable land-use scenario (industrial in this case); the calculated dose value for SWMU 103 for industrial land use is well below this guideline. The estimated excess cancer risk is $1.0 \times 10^{-5}$.

For the residential land-use scenario nonradioactive COCs the HI value increases to 13, and the excess cancer risk is $8 \times 10^{-7}$ (Table 8). The numbers presented included exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although EPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 9 shows an HI of 0.05 for the SWMU 103 associated background constituents and there is no quantifiable excess cancer risk for the residential land-use scenario.

For the radiological COCs incremental TEDE for the residential land-use scenario is 2.7 mrem/yr. The guideline being used is an excess TEDE of 75 mrem/yr (SNL/NM February 1998) for a complete loss of institutional controls (residential land use in this case); the calculated dose value for SWMU 103 for the residential land use is well below this guideline. Consequently, SWMU 103 is eligible for unrestricted radiological release as the residential land-use scenario resulted in an incremental TEDE of less than 75 mrem/yr to the on-site receptor. The estimated excess cancer risk is $3.3 \times 10^{-5}$. The excess cancer risk from the nonradiological COCs and the radiological COCs is not additive, as noted in the RAGS (EPA 1989).

VI.7 Step 6. Comparison of Risk Values to Numerical Guidelines.

The human health risk assessment analysis evaluated the potential for adverse health effects for both an industrial land-use scenario (the designated land-use scenario for this site) and a residential land-use scenario.

For the industrial land-use scenario nonradiological COCs, the HI calculated is 0.05 (considerably less than the numerical guideline of 1 suggested in RAGS [EPA 1989]). Excess cancer risk is estimated at $5.0 \times 10^{-7}$. Guidance from the New Mexico Environment Department (NMED) indicates that excess lifetime risk of developing cancer by an individual must be less than $10^{-6}$ for Class A and B carcinogens and less than $10^{-5}$ for Class C carcinogens (NMED March 1998). The excess cancer risk is driven by chromium, total. Chromium, total is assumed to be chromium VI (most conservative), which is a Class A carcinogen. Thus, the

**Table 8**
**Risk Assessment Values for SWMU 103 Nonradiological COCs**

| COC Name | Maximum Concentration (mg/kg) | Industrial Land-Use Scenario[a] | | Residential Land-Use Scenario[a] | |
|---|---|---|---|---|---|
| | | Hazard Index | Cancer Risk | Hazard Index | Cancer Risk |
| Barium | 220 | 0.00 | -- | 0.03 | -- |
| Cadmium | 5[b] | 0.01 | 2E-9 | 4.09 | 3E-9 |
| Chromium, total[c] | 220 | 0.04 | 5E-7 | 0.18 | 8E-7 |
| Mercury | 0.06[b] N* | 0.00 | -- | 0.10 | -- |
| Nickel | 24 | 0.00 | -- | 0.04 | -- |
| Selenium | 25[b] | 0.00 | -- | 8.8 | -- |
| Silver | 5[b] | 0.00 | -- | 0.21 | -- |
| Arochlor-1260[d] | 0.012 J | -- | 1E-8 | -- | 4E-8 |
| | | | | | |
| **Total** | | **0.05** | **5E-7** | **13** | **8E-7** |

[a]From EPA (1989).
[b]COC not detected, concentration is assumed to be one-half of detection limit.
[c]Chromium, total is assumed to be chromium VI (most conservative).
[d]Arochlor specific cancer risk is calculated in terms of PCBs, total (see Table 6)
COC = Constituents of concern.
EPA = U.S. Environmental Protection Agency.
J = Estimated concentration.
mg/kg = Milligram(s) per kilogram.
N* = Matrix spike recovery exceeded acceptance limits and the relative percent difference for the duplicate analysis exceeded acceptance limits.
SWMU = Solid waste management unit.
-- = Information not available.

**Table 9**
**Risk Assessment Values for SWMU 103 Nonradiological Background Constituents**

| COC Name | Background Concentration[a] (mg/kg) | Industrial Land-Use Scenario[b] | | Residential Land-Use Scenario[b] | |
|---|---|---|---|---|---|
| | | Hazard Index | Cancer Risk | Hazard Index | Cancer Risk |
| Barium | 130 | 0.00 | -- | 0.02 | -- |
| Cadmium | <1 | -- | -- | -- | -- |
| Chromium, total[c] | 17.3 | 0.00 | -- | 0.01 | -- |
| Mercury | <0.25 | -- | -- | -- | -- |
| Nickel | 11.5 | 0.00 | -- | 0.02 | -- |
| Selenium | <1 | -- | -- | -- | -- |
| Silver | <1 | -- | -- | -- | -- |
| **Total** | | **0.00** | -- | **0.05** | -- |

[a]From Dinwiddie (September 24, 1997), Southwest Test Area.
[b]From EPA (1989).
[c]Chromium, total assumed to be chromium III.
-- Information not available.

excess cancer risk for this site is below the suggested acceptable risk value ($10^{-6}$). This risk assessment also determined risks considering background concentrations of potential nonradiological COCs for both industrial and residential land-use scenarios. For nonradiological COCs, assuming the industrial land-use scenario, the HI is 0.00. There is no quantifiable excess cancer risk. Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and therefore may appear inconsistent with numbers presented in tables and within the text. Incremental HI is 0.05 and incremental cancer risk is $5.1 \times 10^{-7}$ for the industrial land-use scenario. These incremental risk calculations indicate insignificant risk to human health from nonradiological COCs considering an industrial land-use scenario.

For radiological COCs of the industrial land-use scenario, incremental TEDE is $9.4 \times 10^{-1}$ mrem/yr, which is significantly less than EPA's numerical guideline of 15 mrem/yr. The incremental estimated excess cancer risk is $1.0 \times 10^{-5}$.

For residential land-use scenario nonradiological COCs, the calculated HI is 13, which is above the numerical guidance. The excess cancer risk is estimated at $8 \times 10^{-7}$. The excess cancer risk is again driven by chromium, total. Chromium, total is assumed to be chromium VI (most conservative), which is a Class A carcinogen. Therefore, the excess cancer risk for this site is below the suggested acceptable risk value ($10^{-6}$). The HI for associated background for the residential land-use scenario is 0.05. There is no quantifiable excess cancer risk. The incremental HI is 13.4 and the incremental cancer risk is $8.4 \times 10^{-7}$ for the residential land-use scenario. These incremental risk calculations indicate significant contribution to human health risk from the COCs considering a residential land-use scenario.

The incremental TEDE for a residential land-use scenario from the radiological components is 2.7 mrem/yr, which is significantly less than the numerical guideline of 75 mrem/yr suggested in

SNL/NM RESRAD Input Parameter Assumptions and Justification (SNL/NM February 1998). The estimated excess cancer risk is $3.3 \times 10^{-5}$.

## VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 103 was based upon an initial conceptual model validated with scoping and VCM sampling programs conducted at the site. The scoping sampling was implemented in accordance with the site-specific Sampling and Analysis Plan (SNL/NM July 1995). The VCM sampling was implemented in accordance with sampling procedures defined in the final report documenting VCM activities at SWMU 103 (SNL/NM September 1997). The DQOs achieved by the sampling programs conducted at SWMU 103 are appropriate for use in risk screening assessments. The data collected, based upon sample location, density, and depth, are representative of worst-case conditions at the site. The analytical requirements and results satisfy the DQOs. Data quality was validated in accordance with SNL/NM procedures (SNL/NM July 1994). Therefore, there is no uncertainty associated with the data quality used to perform the risk screening assessment at SWMU 103.

Because of the location, history of the site, and future land use (DOE and USAF March 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values. This means that the parameter values used in calculations were conservative and that the calculated intakes are probably overestimates. Maximum measured values of the concentrations of the COCs were used to provide conservative results.

Table 6 shows the uncertainties (confidence) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from IRIS (EPA 1998), HEAST (EPA 1997a), EPA Region 9 (EPA 1996c) and EPA Region 3 (EPA 1997b) databases. Where values are not provided, information is not available from the HEAST (1997a), IRIS (EPA 1998), or the EPA regions (EPA 1996c, 1997b). Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The risk assessment values for the nonradiological COCs are within the human health acceptable range for the industrial land-use scenario compared to the established numerical guidance.

For radiological COCs, the conclusion of the risk assessment is that potential effects on human health for both industrial and residential land-use scenarios are within guidelines and are a small fraction of the estimated 360 mrem/yr received by the average U.S. population (NCRP 1987).

The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

### VI.9 Summary

SWMU 103 has identified COCs consisting of some inorganic, organic, and radiological compounds. Because of the location of the site, the designated industrial land-use scenario, and the nature of contamination, potential exposure pathways identified for this site included soil ingestion and dust inhalation for chemical constituents and soil ingestion, dust inhalation, and direct gamma exposure for radionuclides. Plant uptake was included as an exposure pathway for the residential land-use scenario.

Using conservative assumptions and employing an RME approach to risk assessment, calculations for nonradiological COCs show that for the industrial land-use scenario the HI (0.05) is significantly less than the accepted numerical guidance from the EPA. The excess cancer risk ($5 \times 10^{-7}$) is also below the acceptable risk value provided by the NMED for an industrial land use (NMED March 1998). The incremental HI is 0.05, and the incremental cancer risk is $5.1 \times 10^{-7}$ for the industrial land-use scenario. Incremental excess cancer risk calculations indicate insignificant risk to human health for an industrial land-use scenario.

Incremental TEDE and corresponding estimated cancer risk from radiological COCs are much less than EPA guidance values; the estimated TEDE is $9.4 \times 10^{-1}$ mrem/yr for the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr in EPA guidance (EPA 1997c). The corresponding incremental estimated cancer risk value is $1.0 \times 10^{-5}$ for the industrial land-use scenario. Furthermore, the incremental TEDE for the residential land-use scenario that results from a complete loss of institutional control is only 2.7 mrem/year. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore, SWMU 103 is eligible for unrestricted radiological release.

Uncertainties associated with the calculations are considered small relative to the conservativeness of risk assessment analysis. It is therefore concluded that this site does not have a potential to affect human health under an industrial land-use scenario.

## VII. Ecological Risk Screening Assessment

### VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils at SWMU 103, Scrap Yard (Building 9939). A component of the NMED Risk-Based Decision Tree is to conduct an ecological screening assessment that corresponds with that presented in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997d). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed screening assessment. Initial components of NMED's decision tree (a discussion of DQOs, a data assessment, and evaluations of bioaccumulation and fate-and-transport potential) are addressed in the scoping assessment (Section VII.2), with the exception of DQOs, which are reviewed in Section II of this report. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a screening assessment whereby a more quantitative estimate of ecological risk is conducted. Although this assessment incorporates conservatisms in the estimation of ecological risks, ecological relevance and professional judgment are also used as

recommended by the EPA (1996d) to ensure that predicted exposures of selected ecological receptors reasonably reflect those expected to occur at the site.

## VII.2 Scoping Assessment

The scoping assessment focuses primarily on the likelihood of exposure of biota at/or adjacent to the site to be exposed to constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A Scoping Risk Management Decision will involve a summary of the scoping results and a determination as to whether further examination of potential ecological impacts is necessary.

### VII.2.1 Data Assessment

As indicated in Section IV (Tables 3 and 4), constituents in soil within the 0- to 5-foot-depth interval that exceeded background concentrations were:

- Barium
- Chromium (total)
- Lead
- Nickel
- Th-234
- U-234
- U-235
- U-238.

In addition, cadmium, mercury, selenium, and silver were reported as not detected with detection limits exceeding background concentrations. Bismuth-214 and lead-214 were considered to have half-lives too short to result in significant radiological exposure.

The only organic analyte detected in soil was the PCB Arochlor-1260.

### VII.2.2 Bioaccumulation

Among the COCs listed in Section VII.2.1, the following were considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 3 and 4):

- Barium
- Cadmium
- Lead
- Mercury
- Nickel
- Selenium
- PCB Arochlor-1260
- Th-234
- U-234

- U-235
- U-238.

It should be noted, however, that as directed by the NMED (March 1998), bioaccumulation is assessed exclusively based upon log $K_{ow}$ values and maximum reported bioconcentration factors (BCF) for aquatic species. Because only aquatic BCFs are used to evaluate the bioaccumulation potential for metals, bioaccumulation in terrestrial species is likely to be overpredicted.

### VII.2.3 Fate and Transport Potential

The potential for the COPECs to move from the source of contamination to other media or biota is discussed in Section V. As noted in Table 5 (Section V), moderate fate and transport may occur due to wind dispersion. Surface-water runoff is expected to be of moderate to low significance, while transformation and degradation are expected to be low. Food-chain uptake is expected to be of low significance for inorganic COCs but may be moderate to high for PCBs, depending on contact with biological receptors. Migration to groundwater is not anticipated. PCB concentrations did not exceed Toxic Substances Control Act, RCRA, or Comprehensive Environmental Response, Compensation, and Liability Act cleanup criteria.

### VII.2.4 Scoping Risk Management Decision

Based on information gathered through the scoping assessment, it was concluded that complete ecological pathways may be associated with this SWMU and that COPECs also exist at the site. As a consequence, a screening assessment was deemed necessary to predict the potential level of ecological risk associated with the site.

## VII.3 Screening Assessment

As concluded in Section VII.2.4, complete ecological pathways and COPECs are associated with this SWMU. The screening assessment performed for the site involves a quantitative estimate of current ecological risks using exposure models in association with exposure parameters and toxicity information obtained from the literature. The estimation of potential ecological risks is conservative to ensure ecological risks are not underpredicted.

Components within the screening assessment include:

- Problem Formulation–sets the stage for the evaluation of potential exposure and risk
- Exposure Estimation–provides a quantitative estimate of potential exposure
- Ecological Effects Evaluation–presents benchmarks used to gauge the toxicity of COPECs to specific receptors
- Risk Characterization–characterizes the ecological risk associated with exposure of the receptors to environmental media at the site

- Uncertainty Assessment–discusses uncertainties associated with the estimation of exposure and risk

- Risk Interpretation–evaluates ecological risk in terms of HQs and ecological significance

- Screening Assessment Scientific/Management Decision Point–presents the decision to risk managers based on the results of the screening assessment

### VII.3.1 Problem Formulation

Problem formulation is the initial stage of the screening assessment that provides the introduction to the risk evaluation process. Components that are addressed in this section include a discussion of ecological pathways and the ecological setting, identification of COPECs, and selection of ecological receptors. The conceptual model, ecological food webs, and ecological endpoints (other components commonly addressed in a screening assessment) are presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM Environmental Restoration (ER) Program" (IT June 1998) and are not duplicated here.

#### *VII.3.1.1 Ecological Pathways and Setting*

SWMU 103 is located west of Lovelace Road about 2 miles south of Coyote Springs Road and 1.6 miles north of the Solar Power Tower. The approximate size of the site is 6 acres. The primary vegetation within this area is desert grassland vegetation. The topography is flat and there are no major drainages or surface-water features in the area. Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. The permit use area at Building 9939 was previously surveyed by IT Corporation on June 3 and 4, 1992 (IT June 1992). No sensitive species were found at this facility during this survey. Because SWMU 103 is contained within the boundaries of the use area, no sensitive species are expected to occur within or adjacent to SWMU 103.

Direct uptake of COPECs from soil was assumed to be the major route of exposure for plants, with exposure of plants to wind-blown soil assumed to be minor. Exposure modeling for wildlife receptors was limited to food and soil ingestion pathways. Because of the lack of surface water at this site, exposure to COPECs through the ingestion of surface water was considered insignificant. Inhalation and dermal contact were also considered insignificant pathways with respect to ingestion (Sample and Suter 1994). The nearest groundwater monitoring well, LMF-1, is located approximately 1,400 feet from SWMU 103 at the Large Melt Facility. The depth to groundwater at LMF-1 varied between 335 feet in January 1996 and 292 feet in December 1996 (SNL/NM September 1997). The nearest production well, KAFB-4, is located approximately 5 miles northwest of the site. Groundwater is not expected to be affected by COPECs at this site.

### *VII.3.1.2 COPECs*

The COPECs considered for the ecological risk assessment are listed in Section VII.2. In order to provide conservatism in this ecological risk screening assessment, it is based upon the maximum soil concentrations of the COPECs as measured in soil samples collected from depths of 0 to 5 feet. Both radiological and nonradiological COPECs are evaluated (Section IV, Tables 3 and 4). The nonradiological COPECs include both metals and PCBs. Inorganic analytes were screened against background concentrations, and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 24, 1997) for the area were considered to be COPECs. The PCB Arochlor-1260 was the only organic analyte detected in surface soil samples. Because no background screening values exist for PCBs, Arochlor-1260 was included as a COPEC. In addition, cadmium, mercury, selenium, and silver reported as not detected were modeled at one-half of the method detection limit. Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (EPA 1989). Radiological COPECs include U-234, U-235, U-238, and Th-234.

### *VII.3.1.3 Ecological Receptors*

As described in detail in IT (June 1998), a nonspecific perennial plant was selected as the receptor to represent plant species at the site. Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associate with the site. A deer mouse (*Peromyscus maniculatus*) and burrowing owl (*Speotyto cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected as the top predator. It is present at SNL/NM and is designated as a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995).

## VII.3.2 Exposure Estimation

Direct uptake of COPECs from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 10 presents the species-specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT June 1998).

## Table 10
## Exposure Factors for Ecological Receptors at SWMU 103

| Receptor Species | Class/Order | Trophic Level | Body Weight (kg)[a] | Food Intake Rate (kg/day)[b] | Dietary Composition[c] | Home Range (acres) |
|---|---|---|---|---|---|---|
| Deer mouse (*Peromyscus maniculatus*) | Mammalia/ rodentia | Herbivore | 2.39E-2[d] | 3.72E-3 | Plants: 100% (+ Soil at 2% of intake) | 2.7E-1[e] |
| Deer mouse (*Peromyscus maniculatus*) | Mammalia/ rodentia | Omnivore | 2.39E-2[d] | 3.72E-3 | Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake) | 2.7E-1[e] |
| Deer mouse (*Peromyscus maniculatus*) | Mammalia/ rodentia | Insectivore | 2.39E-2[d] | 3.72E-3 | Invertebrates: 100% (+ Soil at 2% of intake) | 2.7E-1[e] |
| Burrowing owl (*Speotyto cunicularia*) | Aves/ strigiformes | Carnivore | 1.55E-1[f] | 1.73E-2 | Rodents: 100% (+ Soil at 2% of intake) | 3.5E+1[g] |

[a]Body weights are in kilograms wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2 percent of food intake.
[d]From Silva and Downing (1995).
[e]From EPA (1993), based upon the average home range measured in semiarid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).
kg = Kilogram(s).
kg/day = Kilogram(s) per day.
SWMU = Solid waste management unit.

Although home range is also included in this table, exposures for this risk assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated. The maximum measured COPEC concentrations from surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

For the radiological dose rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from U-234, U-235, U-238, and Th-234. Internal and external dose rates to the deer mouse and burrowing owl are approximated using modified dose rate models from the *Hanford Site Risk Assessment Methodology* (DOE 1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Program (IT June 1998).

Radionuclide-dependent data for the dose rate calculations were obtained from Baker and Soldat (1992). The external dose rate model examines the total-body dose rate to a receptor residing in soil exposed to radionuclides. The soil surrounding the receptor is assumed to be an infinite medium uniformly contaminated with gamma-emitting radionuclides. The external dose-rate model is the same for both the deer mouse and the burrowing owl. The internal total-body dose rate model assumes that a fraction of the radionuclide concentration ingested by a receptor is absorbed by the body and concentrated at the center of a spherical body shape. This provides for a conservative estimate for absorbed dose. This concentrated radiation source at the center of the body of the receptor is assumed to be a "point" source. Radiation emitted from this point source is absorbed by the body tissues to contribute to the absorbed dose. Alpha and beta emitters are assumed to transfer 100 percent of their energy to the receptor as they pass through tissues. Gamma emitting radionuclides only transfer a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The external and internal dose rate results are summed to calculate a total dose rate due to exposure to radionuclides in soil.

Table 11 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 12 presents maximum soil concentrations and derived tissue concentrations in various food-chain elements that are used to model dietary exposures for each of the wildlife receptors.

### VII.3.3 Ecological Effects Evaluation

Benchmark toxicity values for plant and wildlife receptors are presented in Table 13. For plants, benchmark soil concentrations are based upon the lowest-observed-adverse-effect level. For wildlife, toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Insufficient toxicity information was found to estimate the NOAELs for some COPECs for the burrowing owl.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (IAEA 1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation

**Table 11**
**Transfer Factors Used in Exposure Models for**
**Constituents of Potential Ecological Concern at SWMU 103**

| Constituent of Potential Ecological Concern | Soil-to-Plant Transfer Factor | Soil-to-Invertebrate Transfer Factor | Food-to-Muscle Transfer Factor |
|---|---|---|---|
| Inorganic | | | |
| Barium | 1.5E-1[a] | 1.0E+0[b] | 2.0E-4[c] |
| Cadmium | 5.5E-1[a] | 6.0E-1[d] | 5.5E-4[a] |
| Chromium (total) | 4.0E-2[c] | 1.3E-1[a] | 3.0E-2[c] |
| Lead | 9.0E-2[c] | 4.0E-2[d] | 8.0E-4[c] |
| Mercury | 1.0E+0[c] | 1.0E+0[b] | 2.5E-1[a] |
| Nickel | 2.0E-1[c] | 3.8E-1[a] | 6.0E-3[a] |
| Selenium | 5.0E-1[c] | 1.0E+0[b] | 1.0E-1[c] |
| Silver | 1.0E+0[c] | 2.5E-1[d] | 5.0E-3[c] |
| Organic | | | |
| PCB, Arochlor-1260 | 1.1E-2[f] | 2.7E+1[g] | 3.8E-2[f] |

[a]From Baes et al. (1984).
[b]Default value.
[c]From NCRP (1989).
[d]From Stafford et al. (1991).
[e]From Ma (1982).
[f]From equation developed in Travis and Arms (1988).
[g]From equation developed in Connell and Markwell (1990).
SWMU = Solid waste management unit.

than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad/day would also offer sufficient protection to other components within the terrestrial habitat of SWMU 103.

### VII.3.4 Risk Characterization

Maximum soil concentrations and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Results of these comparisons are presented in Table 14. HQs are used to quantify the comparison with benchmarks for plants and wildlife exposure.

Analytes with HQs exceeding unity for plants were cadmium, chromium (total), lead, selenium, and silver. The maximum among these HQs was a value of 220 associated with chromium. Selenium was the only analyte with an HQ exceeding unity for the herbivorous mouse. Inclusion of soil invertebrates in the model diet of the deer mouse (i.e., omnivorous and insectivorous diets) resulted in HQs greater than 1.0 for barium and selenium. No mouse HQ exceeded a value of 10. Selenium resulted in an HQ of 1.7 for the burrowing owl, although HQs for the burrowing owl could not be determined for beryllium, silver, and the PCB Arochlor-1260. As directed by the NMED, HIs were calculated for each receptor. The HI is the sum of chemical-specific HQs for all pathways for a given receptor. All receptors had HIs greater than unity.

**Table 12**
**Media Concentrations[a] for Constituents of Potential Ecological Concern at SWMU 103**

| Constituent of Potential Ecological Concern | Soil (maximum) | Plant Foliage[b] | Soil Invertebrate[b] | Deer Mouse Tissues[c] |
|---|---|---|---|---|
| Inorganic | | | | |
| Barium | 2.2E+2 | 3.3E+1 | 2.2E+2 | 8.2E-2 |
| Cadmium | 5.0E+0[d] | 2.8E+0 | 3.0E+0 | 5.1E-3 |
| Chromium (total) | 2.2E+2 | 8.8E+0 | 2.9E+1 | 2.2E+0 |
| Lead | 9.1E+2 | 8.2E+1 | 3.6E+1 | 1.9E-1 |
| Mercury | 6.0E-2[d] | 6.0E-2 | 6.0E-2 | 4.8E-2 |
| Nickel | 2.4E+1 | 4.8E+0 | 9.1E+0 | 1.4E-1 |
| Selenium | 2.5E+1[d] | 1.3E+1 | 2.5E+1 | 6.0E+0 |
| Silver | 5.0E+0[d] | 5.0E+0 | 1.3E+0 | 5.0E-2 |
| Organic | | | | |
| PCB, Arochlor-1260 | 1.2E-2 | 1.4E-4 | 3.2E-1 | 1.9E-2 |

[a]In milligram(s) per kilogram. All are based upon dry weight of the media.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Based upon the deer mouse with an omnivorous diet. Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from EPA 1993).
[d]The element was not detected. The reported value is actually one-half of the maximum analytical detection limit.
SWMU = Solid waste management unit.

Tables 15 and 16 summarize the internal and external dose rate model results for the three radionuclides. The total radiation dose rate to the deer mouse was predicted to be 5.2E-3 rad/day. Total dose rate to the burrowing owl was predicted to be 5.0E-3 rad/day. The external dose rate from exposure to these radionuclides for both receptors is the primary contributor to the total dose rate. The radiation dose rates for the deer mouse and the burrowing owl are considerably less than the benchmark of 0.1 rad/day.

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at SWMU 103. These uncertainties result from assumptions used in calculating risk that may overestimate or underestimate true risk presented at a site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions protect ecological resources potentially affected at the site. Conservatisms incorporated into this risk assessment include the use of the maximum measured soil concentrations to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, the use of earthworm-based transfer factors for modeling COPECs into soil invertebrates in the absence of insect data, the incorporation of strict herbivorous and

## Table 13
## Toxicity Benchmarks for Ecological Receptors at SWMU 103

| Constituent of Potential Ecological Concern | Plant Benchmark[a,b] | Mammalian NOAELs | | | Avian NOAELs | | |
|---|---|---|---|---|---|---|---|
| | | Mammalian Test Species[c,d] | Test Species NOAEL[d,e] | Deer Mouse NOAEL[e,f] | Avian Test Species[d] | Test Species NOAEL[d,e] | Burrowing Owl NOAEL[e,g] |
| Inorganic | | | | | | | |
| Barium | 500 | Rat[h] | 5.1 | 10.5 | Chicks | 20.8 | 20.8 |
| Cadmium | 3 | Rat[i] | 1.0 | 1.9 | Mallard | 1.45 | 1.45 |
| Chromium (total) | 1 | Rat | 2,737 | 5,354 | Black duck | 1.0 | 1.0 |
| Lead | 50 | Rat | 8 | 16 | American kestrel | 3.85 | 3.85 |
| Mercury (inorganic) | 0.3 | Mouse | 13.2 | 14.0 | Japanese quail | 0.45 | 0.45 |
| Mercury (organic) | 0.3 | Rat | 0.032 | 0.06 | Mallard | 0.0064 | 0.0064 |
| Nickel | 30 | Rat | 40 | 78 | Mallard | 77.4 | 77.4 |
| Selenium | 1 | Rat | 0.20 | 0.39 | Screech owl | 0.44 | 0.44 |
| Silver | 2 | Rat | 17.8 | 34.8 | ---[j] | --- | --- |
| Organic | | | | | | | |
| PCB, Arochlor-1260 | 40[k] | Rat | 0.04 | 0.08 | --- | --- | --- |

[a]In milligrams per kilogram soil.
[b]From Will and Suter (1995), except where noted.
[c]Body weights (in kilograms) for the no-observed-adverse-effect level (NOAEL) conversion are as follows: lab mouse, 0.030; lab rat, 0.350 (except where noted).
[d]From Sample et al. (1996).
[e]In milligrams per kilogram body weight per day.
[f]Based upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kilogram and a mammalian scaling factor of 0.25.
[g]Based upon NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[h]Body weight: 0.435 kilogram.
[i]Body weight: 0.303 kilogram.
[j]--- designates insufficient toxicity data.
[k]Based upon plant benchmark for PCB Arochlor-1254.

## Table 14
## Hazard Quotients for Ecological Receptors at SWMU 103

| Constituent of Potential Ecological Concern | Plant Hazard Quotient[a] | Deer Mouse HQ (Herbivorous)[a] | Deer Mouse HQ (Omnivorous)[a] | Deer Mouse HQ (Insectivorous)[a] | Burrowing Owl HQ[a] |
|---|---|---|---|---|---|
| Inorganic | | | | | |
| Barium | 4.4E-1 | 5.5E-1 | **1.9E+0** | **3.3E+0** | 2.4E-2 |
| Cadmium | **1.7E+0** | 2.4E-1 | 2.5E-1 | 2.6E-1 | 8.1E-3 |
| Chromium (total) | **2.2E+2** | 3.8E-4 | 6.7E-4 | 9.6E-4 | 7.3E-1 |
| Lead | **1.8E+1** | 1.0E-2 | 7.7E-1 | 5.4E-1 | 5.3E-1 |
| Mercury (inorganic) | 2.0E-1 | 6.8E-4 | 6.8E-4 | 6.8E-4 | 1.2E-2 |
| Mercury (organic) | 2.0E-1 | 1.5E-1 | 1.5E-1 | 1.5E-1 | 8.5E-1 |
| Nickel | 8.0E-1 | 1.1E-2 | 1.5E-2 | 1.9E-2 | 8.9E-4 |
| Selenium | **2.5E+1** | **5.2E+0** | **7.7E+0** | **1.0E+1** | **1.7E+0** |
| Silver | **2.5E+0** | 2.3E-2 | 1.4E-2 | 6.0E-3 | ---[b] |
| Organic | | | | | |
| PCB, Arochlor-1260 | 3.0E-4 | 7.5E-4 | 3.2E-1 | 6.4E-1 | --- |
| | | | | | |
| Hazard index[c] | **2.7E+2** | **6.2E+0** | **1.1E+1** | **1.5E+1** | **3.8E+0** |

[a]**Bold** text indicates HQ or HI exceeds unity.

[b]--- designates insufficient toxicity data available for risk estimation purposes.

[c]The HI is the sum of individual HQs using the values for organic mercury as a conservative estimate of the HI.

HI = Hazard index.
HQ = Hazard quotient.
PCB = Polychlorinated biphenyls.
SWMU = Solid waste management unit.

**Table 15**
**Internal and External Dose Rates for**
**Deer Mice Exposed to Radionuclides at SWMU 103**

| Radionuclide | Maximum Concentration (pCi/g) | Internal Dose (rad/day) | External Dose (rad/day) | Total Dose (rad/day) |
|---|---|---|---|---|
| U-234 | 3.92E+0 | 4.4E-5 | 4.4E-7 | 4.4E-5 |
| U-235[a] | 8.8E-1 | 9.2E-6 | 1.4E-5 | 2.4E-5 |
| U-238 | 3.1E+1 | 3.1E-4 | 4.8E-3 | 5.1E-3 |
| Th-234+D[b] | 5.2E+1 | 5.4E-8 | 8.1E-5 | 8.1E-5 |
| Total | | 3.6E-4 | 4.9E-3 | 5.2E-3 |

[a]The U-235 value was calculated using the U-238 concentration and assuming that the U-238 to U-235 ratio was equal to that detected during waste characterization of depleted uranium-contaminated soils generated during the radiological voluntary corrective measures project, where U-235=U-238/73 (Brown January 14, 1998).
[b]The dose rate calculation for Th-234 includes its radiological daughter, protactinium-234m.
pCi/g = Picocurie(s) per gram.
SWMU = Solid waste management unit.

**Table 16**
**Internal and External Dose Rates for**
**Burrowing Owls Exposed to Radionuclides at SWMU 103**

| Radionuclide | Maximum Concentration (pCi/g) | Internal Dose (rad/day) | External Dose (rad/day) | Total Dose (rad/day) |
|---|---|---|---|---|
| U-234 | 3.92E+0 | 1.7E-5 | 4.4E-7 | 1.7E-5 |
| U-235[a] | 8.8E-1 | 3.5E-6 | 1.4E-5 | 1.8E-5 |
| U-238 | 3.1E+1 | 1.2E-4 | 4.8E-3 | 4.9E-3 |
| Th-234+D[b] | 5.2E+1 | 3.7E-8 | 8.1E-5 | 8.1E-5 |
| Total | | 1.4E-4 | 4.9E-3 | 5.0E-3 |

[a]The U-235 value was calculated using the U-238 concentration and assuming that the U-238 to U-235 ratio was equal to that detected during waste characterization of DU-contaminated soils generated during the radiological voluntary corrective measures project, where U-235=U-238/73 (Brown January 14, 1998).
[b]The dose rate calculation for Th-234 includes its radiological daughter, protactinium-234m.
DU = Depleted uranium.
pCi/g = Picocurie(s) per gram.
SWMU = Solid waste management unit.

insectivorous diets for predicting the extreme HQ values for the deer mouse, and the use of 1.0 as the area use factor for wildlife receptors regardless of seasonal use or home range size. Each of these uncertainties, which are consistent among each of the ER-specific ecological risk assessments, is discussed in detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Program (IT June 1998).

Uncertainties associated with the estimating risk to ecological receptors following exposure to U-234, U-235, U-238, and Th-234 are primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors that are typically negligible. The dose rate models used for these calculations are based upon conservative estimates of receptor shape, radiation absorption by body tissues, and intake parameters. The goal is to provide a realistic but conservative estimate of a receptor's exposure to radionuclides in soil, both internally and externally.

Uncertainty associated with the prediction of ecological risks at this site is introduced by using the maximum measured soil concentrations and detection limits to evaluate risk. One-half of the detection limit value was used to estimate potential risk associated with exposure to cadmium, mercury, selenium, and silver that may give a false impression of ecological risks. This is especially relevant with regard to potential impacts to vegetation communities (rather than individual plants) and to mobile wildlife.

Analytical data were examined more closely to assess variability. It was predicted that cadmium, chromium, lead, selenium, and silver would be hazardous to plants based upon exposure to either maximum soil concentrations or one-half the analytical reporting limit. As mentioned above, predicted risk associated with cadmium and selenium were attributed to utilization of one-half the detection limit as the exposure concentration. Chromium was detected in 33 percent of the samples (6 out of 18 samples). Detected concentrations ranged from 6.9 to 220 mg/kg, with an average concentration of 24 mg/kg. Exposure of plants to the overall average chromium concentration on site would result in an HQ greater than one. Lead was detected in 50 percent of the samples (9 out of 18 samples). Detected concentrations ranged from 5.0 to 910 mg/kg, with an average concentration of 64 mg/kg. The average concentration is, however, skewed toward the highest detected concentration that exceeds the next highest value by 858 mg/kg. Elimination of this particular hot spot of lead from the site would result in estimating an HQ less than one for plants. Based upon this analysis, risks to plants are only anticipated at the location where the lead concentration in soil was measured at 910 mg/kg.

Barium and selenium were predicted to be potentially hazardous to resident wildlife. Barium was detected in all soil samples collected (18 samples). Concentrations ranged from 64 to 220 mg/kg, with an average concentration of 140 mg/kg. Exposure of mice to the average barium concentration on site resulted in an HQ of approximately one. As discussed above, potential risk predicted for deer mice and burrowing owls exposed to selenium is attributed to use of one-half the detection limit as an exposure concentration.

In estimating ecological risk, background concentrations are included as a component of maximum on-site concentrations. Table 17 illustrates risk estimates associated with exposure of each of the receptors to background concentrations of the metal COPECs. With respect to

## Table 17
## Hazard Quotients for Ecological Receptors Exposed to Background Concentrations for SWMU 103

| Constituent of Potential Ecological Concern | Plant HQ[a] | Deer Mouse HQ (Herbivorous)[a] | Deer Mouse HQ (Omnivorous)[a] | Deer Mouse HQ (Insectivorous)[a] | Burrowing Owl HQ[a] |
|---|---|---|---|---|---|
| Inorganic | | | | | |
| Barium | 2.6E-1 | 3.3E-1 | **1.1E+0** | **2.0E+0** | 1.4E-2 |
| Cadmium | 1.7E-1 | 2.4E-2 | 2.5E-2 | 2.6E-2 | 8.1E-4 |
| Chromium (total) | **1.7E+1** | 3.0E-5 | 5.3E-5 | 7.5E-5 | 5.8E-2 |
| Lead | 4.3E-1 | 2.3E-2 | 1.8E-2 | 1.3E-2 | 1.3E-2 |
| Mercury (inorganic) | 4.2E-1 | 1.4E-3 | 1.4E-3 | 1.4E-3 | 2.5E-2 |
| Mercury (organic) | 4.2E-1 | 3.2E-1 | 3.2E-1 | 3.2E-1 | **1.8E+0** |
| Nickel | 3.8E-1 | 5.0E-3 | 7.1E-3 | 9.2E-3 | 4.3E-4 |
| Selenium | 5.0E-1 | 1.0E-1 | 1.5E-1 | 2.0E-1 | 3.3E-2 |
| Silver | 2.5E-1 | 2.3E-3 | 1.4E-3 | 6.0E-4 | --- |
| | | | | | |
| Hazard index[c] | **1.9E+1** | 8.1E-1 | **1.6E+0** | **2.6E+0** | **1.9E+0** |

[a]**Bold** text indicates HQ or HI exceeds unity.
[b]--- designates insufficient toxicity data available for risk estimation purposes.
[c]The HI is the sum of individual HQs using the value for organic mercury as a conservative estimate of the HI.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid waste management unit.

the plant, an HQ greater than one was obtained for chromium (total). Background accounts for approximately 8 percent of the estimated risk from chromium to plants. However, background constitutes 72 percent of the average chromium concentration associated with the site. HQs greater than unity were also obtained for the omnivorous and insectivorous deer mouse exposed to barium. Almost 60 percent of the on-site maximum barium soil concentration was associated with background. Because of the uncertainties associated with exposure and toxicity, it is unlikely that barium, with an exposure concentration largely attributable to background, presents significant ecological risks.

As illustrated above, consideration of site-specific exposure conditions results in a more realistic estimation of risk. Based upon the minimum reported home range size of 35 acres for the burrowing owl and the size of the Scrap Yard at Building 9939 (6 acres), an area use factor of approximately 0.17 or less could be applied to the HQs for this species. This would result in HQ estimates of less than 3.0 for the burrowing owl, indicating little potential for adverse risks to the owl from exposure to COPECs at SWMU 103.

Based upon this uncertainty analysis, ecological risks at SWMU 103 are expected to be low based upon possible impacts to vegetation from exposure to chromium and lead. HQs greater than unity were initially predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration, background risk, quality of analytical data, and the use of detection limits as exposure concentrations.

### VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 103 were estimated through a screening assessment that incorporates site-specific information when available. Overall, ecological risks to plants are low because predicted risks associated with exposure to cadmium, selenium, and silver are based upon calculations using one-half of the detection limit value and because predicted risks associated with exposure to chromium (total) and lead are based upon maximum measured concentrations. With respect to the mouse, risk is also low. Predicted risk from exposure to selenium was attributed to the use of one-half of the detection limit in estimating risk. In addition, the average barium concentration at the site was within the range of background concentrations. Selenium was predicted to be potentially hazardous to the burrowing owl. As discussed above, the selenium concentration used in the risk model was based upon the detection limit. In actuality, the SWMU constitutes less than 20 percent of the owl's home range. Based upon this final analysis, ecological risks associated with SWMU 103 are low based primarily upon possible impacts to vegetation from exposure to chromium and lead.

### VII.3.7 Screening Assessment Scientific/Management Decision Point

Once potential ecological risks associated with the site have been assessed, a decision is made as whether the site should be recommended for NFA or additional data collected to more thoroughly assess actual ecological risk at the site. With respect to this site, ecological risks were predicted to be low. The scientific/management decision is to recommend this site for NFA.

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# Appendix 1
# EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

## Background

Sandia National Laboratories/New Mexico (SNL/NM) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM SWMUs have similar types of contamination and physical settings, SNL/NM believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL/NM views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the USEPA Region VI and NMED, SNL/NM proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all ER sites exist within the boundaries of the Kirtland AFB. Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM SWMUs. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index, risk and dose values. EPA (EPA 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water;
- Ingestion of contaminated soil;
- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products;
- Ingestion of contaminated surface water while swimming;
- Dermal contact with chemicals in water;
- Dermal contact with chemicals in soil;
- Inhalation of airborne compounds (vapor phase or particulate), and;

- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based upon the location of the SNL/NM SWMUs and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM SWMUs, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land use scenarios, SNL/NM ER has therefore excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM SWMU:

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products; and
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based upon this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a and 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations

**Table 1**
**Exposure Pathways Considered for Various Land Use Scenarios**

| Industrial | Recreational | Residential |
|---|---|---|
| Ingestion of contaminated drinking water | Ingestion of contaminated drinking water | Ingestion of contaminated drinking water |
| Ingestion of contaminated soil | Ingestion of contaminated soil | Ingestion of contaminated soil |
| Inhalation of airborne compounds (vapor phase or particulate) | Inhalation of airborne compounds (vapor phase or particulate) | Inhalation of airborne compounds (vapor phase or particulate) |
| Dermal contact | Dermal contact | Dermal contact |
| External exposure to penetrating radiation from ground surfaces | External exposure to penetrating radiation from ground surfaces | Ingestion of fruits and vegetables |
| | | External exposure to penetrating radiation from ground surfaces |

used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for industrial, recreational, and residential scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., Hazard Quotient/Index, excess cancer risk, or radiation TEDE [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \qquad (1)$$

where

C = contaminant concentration (site specific);
CR = contact rate for the exposure pathway;
EFD= exposure frequency and duration;
BW = body weight of average exposure individual;
AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or hazard index) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially

acceptable risk range of $10^{-4}$ to $10^{-6}$. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the Hazard Index) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard HI of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for used by SNL/NM at SWMUs, based upon the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL/NM is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL/NM proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL/NM SWMUs, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land use, SNL/NM will provide risk parameter values based upon a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on SNL/NM SWMUs. The parameter values are based upon EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL/NM will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

**Table 2**
**Default Parameter Values for Various Land Use Scenarios**

| Parameter | Industrial | Recreational | Residential |
|---|---|---|---|
| **General Exposure Parameters** | | | |
| Exposure frequency (wk/y) | *** | *** | *** |
| Exposure duration (y) | 30[a,b] | 30[a,b] | 30[a,b] |
| Body weight (kg) | 70[a,b] | 56[a,b] | 70 adult[a,b]<br>15 child |
| Averaging Time (days)<br>for carcinogenic compounds<br>(=70 y x 365 d/y)<br>for noncarcinogenic compounds<br>(=ED x 365 d/y) | 25550[a]<br><br>10950 | 25550[a]<br><br>10950 | 25550[a]<br><br>10950 |
| | | | |
| **Soil Ingestion Pathway** | | | |
| Ingestion rate | 100 mg/d[c] | 6.24 g/y[d] | 114 mg-y/kg-d[a] |
| | | | |
| **Inhalation Pathway** | | | |
| Inhalation rate ($m^3$/yr) | 5000[a,b] | 146[d] | 5475[a,b,d] |
| Volatilization factor ($m^3$/kg) | chemical specific | chemical specific | chemical specific |
| Particulate emission factor ($m^3$/kg) | 1.32E9[f] | 1.32E9[f] | 1.32E9[f] |
| | | | |
| **Water Ingestion Pathway** | | | |
| Ingestion rate (L/d) | 2[a,b] | 2[a,b] | 2[a,b] |
| | | | |
| **Food Ingestion Pathway** | | | |
| Ingestion rate (kg/yr) | NA | NA | 138[b,d] |
| Fraction ingested | NA | NA | 0.25[b,d] |
| | | | |
| **Dermal Pathway** | | | |
| Surface area in water ($m^2$) | 2[b,e] | 2[b,e] | 2[b,e] |
| Surface area in soil ($m^2$) | 0.53[b,e] | 0.53[b,e] | 0.53[b,e] |
| Permeability coefficient | chemical specific | chemical specific | chemical specific |

*** The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 h/d for 250 d/y; for the recreational land use, a value of 2 hr/wk for 52 wk/y is used (EPA 1989b); for a residential land use, all contact rates are given per day for 350 d/y.

[a]RAGS, Vol 1, Part B (EPA 1991).

[b]Exposure Factors Handbook (EPA 1989b)

[c]EPA Region VI guidance.

[d]For radionuclides, RESRAD (ANL 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e]Dermal Exposure Assessment (EPA 1992).

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